Fermilab
FY2002 Self-assessment
Process Assessment Report
For
Technical Division

12-Sep-2002

Division/Section performing assessment

Technical Division

Name of organization that owns assessed process

Engineering & Fabrication Department

Organization Strategy

The central mission of the EF department is to provide engineering and fabrication services for the support of HEP. The work on the US-CMS project allows the TD (and Fermilab) to be involved in the CMS collaboration, and contributes to the overall mission of the Lab and the Division.

Names of Personnel on Assessment team

Jamie Blowers, Quality Assurance Officer
Ted Beale, Quality Control Supervisor

Name of process assessed

The design, procurement, fabrication and shipment of ME234/2 cathode strip chambers for the Endcap Muon portion of the US-CMS project.

Brief description of process to be assessed

The Technical Division is involved with the US-CMS project in areas of project management, design, engineering, procurement and fabrication. The process assessed is the design, procurement, fabrication and shipment of the ME234/2 cathode strip chambers (CSCs) for the EMU portion of the US-CMS project. This process involves both the PPD and the TD, and is carried out in Industrial Center Building (procurement), Industrial Building 4 (warehousing and inspection), Industrial Building 2 (travelers and scanning) Lab 8 (PPD area where panels are machined) and MP9 (chamber fabrication).

Are metrics associated with this process? If so, what are they?

There is a contractual metric connected to Performance Area 1: Critical Outcomes, I. Science Programs, Objective 3, Indicator 1, Measure 1, Metric 3 “performance against the DOE-approved US-CMS Detector construction project baselines.” The internal metric is the production rate of chambers in MP9.

What are the names of the procedures associated with this process?

Since this is a project, there is no single document which describes the entire process. Here is a list of some of the documents reviewed which describe portions of the overall project:

US-CMS Cathode Strip Chamber Quality Assurance Plan
CMS Design Report
US-CMS Project Management Plan
CMS-EMU FNAL Factory Division of Responsibilities
Statement(s) of Work

Are these procedures being followed? Are they current?

The procedures are being followed, and for the most part are current. The QA plan should be updated, and specifics are described below.

Describe the methodology used to assess this process.

This assessment followed the standard methodology for conducting a quality audit. We defined a checklist and a schedule, held opening and closing meetings, interviewed personnel involved with the project, and conducted a detailed review of the documentation and records. A summary report was written and published, and is attached to this report.

Results of the assessment:

Based on this assessment, we conclude that the CSC portion of the US-CMS project should be rated as **excellent**. The project is on schedule, within budget, the completed chambers are successfully passing the validation tests, and morale in the central production facility (MP9) is very high.

The fact that 15 chambers have passed cosmic ray testing here at Fermilab, and 67 chambers have been shipped to UF/UCLA and a portion of those have successfully passed cosmic ray testing there indicates that the existing process controls are adequate. The overall production management system of travelers has historically proven to be very effective at assuring quality, and we see this again with CMS.

Notable practices include the cross training of all MP9 technicians on all MP9 operations, the use of the OnBase scanning system to digitally archive production records, and the high level of morale in MP9.

As stated above, the metrics are connected to meeting the project baseline (so as to meet the deadline for completing production). As of the audit, production is on schedule to meet the deadline.

No major deficiencies were identified. There are four areas where improvements should be made, and those are identified below.

As this was the first QA assessment for the project, there are no prior assessments to which we can compare. However, when reviewing the close-out report for the latest Lehman review, we note that other areas of the US-CMS project have technical issues which need to be resolved, and that the CSC portion did not have any findings. This indicates that the work done within TD compares well to other such projects.

Identified opportunities for improvement

There are four areas which should be addressed to make improvements:

1. Calibration:

Calibration, although mostly satisfactory, did have some issues. There were some pieces of equipment which either had expired calibrations, or no labels stating the calibration status. Project management was aware of some of the problems, but there were others which were not known until the audit. Specifically, there was a label on a Fluke multimeter in MP9 (S/N 74341043) which had all its information rubbed off, and the gages in Lab 8 did not appear to have any calibration identification on them at all.

Action: Correct the calibration label on the Fluke multimeter in MP9.

Action: Review the calibration status of all gages in Lab 8. As needed, have them calibrated and identified as such.

Action: Remind the Technicians that part of the fabrication and testing process is to ensure that only properly calibrated gages are to be used. This means that they should be aware of the calibration status of every gage they use.

2. Traceability

According to the TD Quality Management Program (policy document TD-2010), lot/batch/serial numbers of the parts going into a unit are recorded in the traveler. The project has decided that only minimal traceability is required (i.e. the panels and the wire). All other parts are not traceable back to the manufacturer. It is understood that this was a conscious decision, based on finances and risk. However, this decision does not appear to have been incorporated into any formal project document.

Action: Incorporate the project-specific traceability requirements into an official project document. The Lead Auditor suggests the appropriate document to use is the quality assurance plan.

3. Test & Inspection Specifications

The project has issued a document entitled "Test & Inspection Specifications 5520-ES-

368037". This document defines all the various specifications for the chambers and their sub-components. Part of the audit was to assess whether or not the details from 368037 are appropriately defined in the travelers. It was noted that the requirement in 2.3 of 368037 appears to be measured in step 8.2 of traveler TR-333357. However, no limits are described in the traveler, and so the Technician would need to go to 368037 to know whether or not the result is acceptable.

Action: Confirm that all the specifications in 368037 have been appropriately defined in the travelers, and that limits are included where needed.

4. Traveler requirements

It was noted that step 8.1 of TR-333355 calls for a feeler gage inspection, and the technician actually does a visual inspection. This step is still checked off as being done as written.

Action: Reality should match what is written in the traveler. Either revise the traveler to reflect the visual inspection, or have the inspection performed as currently documented.

Schedule for implementation of improvements

This assessment was just completed, with the report issued on September 30 2002. As a result we have not created a schedule for implementation of the improvements at this time.

Status of improvements from previous assessment

N/A

Attachments (supporting data, worksheets, reports, etc.)

The following documents are included as attachments to this report:

"TD-2002-01 Audit Report" - Internal report summarizing the audit

"TD-2002-01 Audit Plan" - Document which defined the audit plan

"TD-2001-01 Audit Schedule" - Schedule of the audit

"TD-2002-01 Checklist" - Completed checklist, indicating areas reviewed and results

"Quality Assurance Plan" - The QA plan for the TD portion of the US-CMS project.

"CMS Design Report" - Select portions of the CMS design report, specific to the CSCs

"US-CMS Project Management Plan" - Select portions of the US-CMS PMP

"FY2002 Statement of Work" - SOW for FY2002

"ME234/2 Configuration Sheet" - Record of configuration control

"Failure Rate Specifications" - Results of the reliability calculations, translated into specifications for specific parts

"FNAL Factory Responsibilities" - Document defining the responsibilities for everyone involved in the TD portion of the CMS project

"Test & Inspection Specifications ES-368037" - Engineering Specification (ES) defining the various test and inspection criteria for the CSCs

"CMS ME234/2 Traveler list" - List of all travelers used for the fabrication of CSCs

"Completed travelers" - We reviewed a small sample of completed travelers. We chose to look at travelers for one chamber shipped to UF (ME234/2-067) and one chamber shipped to UCLA (ME234/2-045). The travelers attached include:

TR-333357 Anode Panel Routing (Gerber) for ME234/2-A-297 and ME234/2-A-311
TR-333365 Anode Panel Winding for panels ME234/2-A-297 and ME234/2-A-311
TR-333370 Chamber Assembly for ME234/2-045 and ME234/2-067
TR-333479 Chamber Capacitance for ME234/2-045 and ME234/2-067
TR-333255 Chamber HV Training for ME234/2-045 and ME234/2-067
TR-333256 Chamber Packing/Shipping for ME234/2-045 and ME234/2-067

"Discrepancy Report trending charts" - Charts showing the trending analysis done on production defect data

TD-2002-01 CMS Production

Audit Report

September 23, 2002

Introduction:

The Technical Division's responsibilities in the US-CMS project include the detailed design of all cathode-strip-chambers (CSC), the fabrication of all CSC panels, the fabrication of all ME234/2 chambers (without electronics), the shipment of the completed ME234/2 chambers to the US FAST sites (where the electronics are installed) and the shipment of all other chamber parts to overseas fabrication sites (i.e. China and Russia).

MP9 is the facility where the ME234/2 chambers are assembled. It went on line for production chambers in June 2000. As of August 2002, 110 ME234/2 chambers were completed in MP9, and 67 were shipped to the FAST sites. Production of 148 chambers is scheduled to be completed by spring of 2003.

The scope of this assessment was the design, fabrication and shipment of ME234/2 chambers. The goal of the assessment was to verify implementation and effectiveness of the quality assurance system. The purpose of the assessment was to determine whether or not:

1. the system, as designed and documented, has the potential to fulfill the stated need;
2. the system, as implemented, actually fulfills the stated need.

Auditors:

- Jamie Blowers, Quality Assurance Manager *1
- Ted Beale, Quality Control Supervisor *1

Participants:

- Giorgio Apollinari, Manager for Fermilab Factories (L4) *1
- Nelson Chester, Project Engineer *1
- Glenn Smith, MP9 Production Manager *1
- Jeff Whittenkeller, MP9 Production Lead *1
- Bob Jensen, Process Engineering Lead *1
- Pam Isham, Traveler Coordinator *1
- Wendy Travnick, Scanning Clerk
- Helen Szuba-Jensen, MP9 Technician
- Tina Kelly, MP9 Technician
- John Zweibohmer, Acquisition Lead *2
- Linda Alsip, Acquisitioner
- Doug Kelley, IB4 Operations Lead
- Scott Doerr, Lab 8 Technician

*1 indicates attendance at opening and closing meetings

*2 indicates attendance at opening meeting

Summary:

Overall the assessment results are very positive. It is clear that this project was very well thought through before operations began, and that much learning and improvements have been made as the project has progressed. Everyone interviewed had a clear understanding of their responsibilities and how to do their work. It should also be noted that morale was very high within the project, particularly in MP9. The Lead Auditor feels there is a direct connection between morale and quality, and so he places a high value on the level of morale.

Feedback mechanisms are setup, either formally or informally, throughout the project. There are communication channels between each step in the process, therefore feedback is provided to correct problems when necessary. This is a rather large undertaking, and was new work for the Technical Division to become involved in (TD has historically only been a "magnet factory", and so making these chambers was new to the Division). The project is on schedule, and within budget, and it appears to be working like a well-oiled machine at this point.

Notable practices include the cross training of all MP9 technicians on all MP9 operations, the use of the OnBase scanning system to digitally archive production records, and the high level of morale in MP9.

The end result, so far, is that the chambers are doing what they are designed to do. None have yet been installed in the detector, but their functionality has been validated through cosmic ray testing both at Fermilab and at the FAST sites.

Below are a few action items which the auditors ask the project leaders to address (more details can be found in the attached checklist, in the sections marked "Minor Issue"). Since these are minor issues, they do not have a large impact on the overall project, and should be easy to clear up.

In summary, we conclude that the quality system, as designed and documented, has the potential to fulfill the stated need, and the system, as implemented, actually fulfills the stated need. All personnel involved in making this happen should be congratulated.

Comments:

1. Calibration:

   Calibration, although mostly satisfactory, did have some issues. There were some pieces of equipment which either had expired calibrations, or no labels stating the calibration status. Project management was aware of some of the problems, but there were others which were not known until the audit. Specifically, there was a label on a Fluke multimeter in MP9 (S/N 74341043) which had all its information rubbed off, and the gages in Lab 8 did not appear to have any calibration identification on them at all.

   Action: Correct the calibration label on the Fluke multimeter in MP9.

Action: Review the calibration status of all gages in Lab 8. As needed, have them calibrated and identified as such.

Action: Remind the Technicians that part of the fabrication and testing process is to ensure that only properly calibrated gages are to be used. This means that they should be aware of the calibration status of every gage they use.

2. Traceability

According to the TD Quality Management Program (policy document TD-2010), lot/batch/serial numbers of the parts going into a unit are recorded in the traveler. The project has decided that only minimal traceability is required (i.e. the panels and the wire). All other parts are not traceable back to the manufacturer. It is understood that this was a conscious decision, based on finances and risk. However, this decision does not appear to have been incorporated into any formal project document.

Action: Incorporate the project-specific traceability requirements into an official project document. The Lead Auditor suggests the appropriate document to use is the quality assurance plan.

3. Test & Inspection Specifications

The project has issued a document entitled "Test & Inspection Specifications 5520-ES-368037". This document defines all the various specifications for the chambers and their sub-components. Part of the audit was to assess whether or not the details from 368037 are appropriately defined in the travelers. It was noted that the requirement in 2.3 of 368037 appears to be measured in step 8.2 of TR-333357. However, no limits are described in the traveler, and so the Technician would need to go to 368037 to know whether or not the result is acceptable.

Action: Confirm that all the specifications in 368037 have been appropriately defined in the travelers, and that limits are included where needed.

4. Traveler requirements

It was noted that step 8.1 of TR-333355 calls for a feeler gage inspection, and the technician actually does a visual inspection. This step is still checked off as being done as written.

Action: Reality should match what is written in the traveler. Either revise the traveler to reflect the visual inspection, or have the inspection performed as currently documented.

TD-2002-01 CMS

Audit Plan

Scope: ME234/2 chambers (includes design, procurement, inspection, fabrication, shipping)

Goal: Verify implementation and effectiveness of the quality system.

Auditors: Ted Beale, Jamie Blowers

Date: September 12, 2002

Background:

The fabrication of ME234/2 cathode strip chambers (CSC) for the Compact Muon Solenoid (CMS) project is a large project within Technical Division. Fabrication of production devices began in June 2000, and as of June 2002 92 chambers were completed. Production of 148 chambers is scheduled to be completed by spring of 2003.

This audit is intended to be focused more on diagnosis than compliance. We would like to determine whether or not:

1. the CMS quality system, as designed and documented, has the potential to fulfill the stated need;
2. the quality system, as implemented, actually fulfills the stated need.

The process to conduct the audit will include:

1. Reviewing the current QA plan and assessing whether or not the designed system can fulfill its purpose;
2. Reviewing records;
3. Tracing a sample of chambers backwards through the production process;
4. Interviewing project personnel.

Questions:

1. How does TD know what its requirements are (e.g. WBS, MoU, SoW)?
2. How do we know that the CSCs are meeting the design requirements (e.g. can we connect requirements in the CSC design to production/testing)?
3. What is your role?
4. How does your role fit into the entire production process?
5. In your own words, can you describe the purpose of the work you are doing?
6. Can you show me what you do?
7. How do you know that the outcome of your work is sufficient?
8. What do you do if you have a problem?
9. How does your work affect other people involved with the project?
10. What could be done to make things better?

An audit report will be generated and published approximately 5 days after the audit is completed.

TD-2002-01 CMS

Audit Schedule

Task	Duration	Date	Time
Interviews (Lab 8): • Phyllis Deering, Bob Jensen	30 min.	*September 11*	9am
Opening meeting (MP9): • Meet with everyone to review audit purpose and schedule.	15 min.	September 12	8:30am
Interviews (MP9): • Glenn Smith, Pam Isham, technicians (possibly Giorgio Appolinari & Nelson Chester).	2 hours	September 12	8:45am
Interviews (IB2): • Bob Jensen, Wendy Travnick	45 min.	September 12	11:00am
Lunch	1 hour	September 12	12pm
Interviews (IB2): • Giorgio Appolinari, Nelson Chester	60 min.	September 12	1:00pm
Interviews (IB4 - Jamie): • Doug Kelley, Inspectors	60 min.	September 12	2pm
Interviews (ICB - Ted): • Linda Alsip	30 min.	September 12	2pm
Audit team meeting	45 min.	September 12	3:00pm
Closing meeting (MP9): • Meet with everyone to orally present audit findings.	20 min.	September 12	4:00pm

TD-2002-01 CMS ME234/2 - Audit Checklist

Reference	*Criteria*	*Results* *Fully Sat*	 *Minor Issue*	 *Major Issue*	*Comments*
QA plan: 1.2 3)	Deliver compliant chambers to fast sites; - How do you assure that the chambers will arrive in good condition? - What feedback do you receive from the fast sites? What do you do with the feedback? - Shipping specifications? - Packaging specifications? - Other specifications?	☒	☐	☐	Quality is assured through the definition of the Shipping Requirements document and the use of the Shipping Traveler (TR-333256). "Pre-shipping Checklist" is used to make sure that everything is done appropriately. The FAST sites communicate with FNAL when there is a problem with the shipment. One such example was when it was discovered that the method of strapping the crates together did not provide enough rigidity, and so improvements were done to the strapping process (add more straps to each end).
QA plan: 8.2	Cosmic ray test; - number of chambers; - what is done with the results?	☒	☐	☐	Giorgio said that 15 chambers were tested early on in the project, and that the testing confirmed that the chambers were working. The FAST sites do a similar test on all chambers after they install the electronics.
QA plan: Attachment IV; QA plan: section 5; 5520-ES-368037	MP9 operations; - Fabrication: - Travelers; - How are travelers managed (i.e. created, issued, revised)? - Training; - Traceability; - kits; - Inspection & Testing: - Travelers; - verify that all requirements in 368037 are included; - Training; - Traceability;	☐	☒	☐	Travelers are issued to production by Processing Engineering (PE). Production communicates with PE regarding production schedules, and PE issues travelers and parts kits accordingly. There are no problems at present with this process. All MP9 technicians are trained on-the-job in the processes done in MP9. Training records are maintained which identify which techs are trained on which process. *As a matter of rule, all technicians are cross-trained on all operations to allow for the most flexibility.* Regarding the proper use of travelers, every sample looked at was in very good shape (i.e. proper signatures, dates, order of sequence). We looked at

Reference	*Criteria*	*Results* *Fully Sat*	*Minor Issue*	*Major Issue*	*Comments*
	- Test status; - Calibration;				the following in-process travelers: ME234/2-115 333255, ME234/2-116 TR-333370, ME234/2-A-253 TR-333365, ME234/2-A-238 TR-333367, and ME234/2-A-257 333361. Traceability is maintained only on panels and wire. All other parts are not traceable back to the manufacturer. This is counter to the "normal" way of business within TD, but was a decision made by the Project early on. Risk of not having traceability was thought to be minimal, and so it was removed as a project requirement. *This decision does not appear to be captured in any formal way.* We took a sample of specifications defined in 368037, to verify if they were called out in the travelers: *the requirement in 2.3 in 368037 appears to be measured in 8.2 of TR-333357, but there is no specification in the traveler stating the acceptable limits*. Test status is known through the traveler. The traveler stays with the panel/chamber through its time in MP9, and each panel/chamber is uniquely identified. If a panel/chamber does not have a special tag on it, it is assumed to be good (i.e. special tags are placed on bad panels/chambers). We looked at a sample of equipment for calibration. For the most part everything was clearly identified with an up-to-date calibration sticker. There were 2 PREP power supplies with past-due calibrations, and 1 PREP power supply

Reference	*Criteria*	*Results* *Fully Sat*	*Minor Issue*	*Major Issue*	*Comments*
					without a calibration sticker (power supplies used for the HV training). CMS management was already aware of the problem, and had been working with PREP to acquire new (calibrated) supplies. *A Fluke multimeter (S/N 74341043) was found (in the chamber assy area) with a CAL-LABS sticker which had it's information completely rubbed off*. Further investigation found that the meter was under proper calibration.
QA plan: Attachment IV; QA plan: section 5; 5520-ES-368037	Lab 8 operations; - Cutting/Machining: - Travelers; - Training; - Traceability; - kits; - Inspection & Testing: - Travelers; - verify that all requirements in 368037 are included; - Training; - Traceability; - Test status; - Calibration;	☐	☒	☐	Due to special circumstances, the only part of Lab 8 we were able to review was the panel cutting process (it should be noted Lab 8 operations are done under the Particle Physics Division). For the most part, operations looked OK. PE issues travelers to Lab 8 to keep production running. Lab 8 uses the travelers, although *some of the steps are filled out before the work is completed. It was also noted that step 8.1 of TR-333355 is not being done, but is being signed off.* The Technician spoke with Giorgio about this (a while ago) and it was never really taken care of. The step calls for a feeler gage inspection, and a visual inspection is done instead. The traveler we looked at was for ME234/2-A-456. The Lab 8 Technician does weekly maintenance on the Axxiom machine. *There are no indications that testing/measuring equipment is being calibrated* (there aren't calibration labels on any of the devices used for test/measurement). The end result is that MP9 receives these panels (after cutting and routing) and any issues are reported back to Lab 8. The fact that no major

Reference	*Criteria*	*Results* *Fully Sat*	 *Minor Issue*	 *Major Issue*	*Comments*
					issues are surfacing indicates that the work at Lab 8 is sufficient.
QA plan: Attachment IV	"Panel cleaning, Electrical Test"	☒	☐	☐	Electrical test is part of a later traveler.
QA plan: 8.2	Receiving inspection; - Traceability; - Training;	☒	☐	☐	IB4 QC inspectors have been doing their job for many years. There is no issue when it comes to training. Some of the inspection requirements were defined by the Project Engineer and compiled in a book of prints. And although this book does not address all the details of doing the inspections, it was a good place to start. The Project Engineer always answered any questions regarding details. Traceability is maintained during this part of the process. Parts are “routed in”, and assigned a unique “routing form” (RF) number. This number traces the parts back to the PO and date of receipt. Any “quality control reports” (QCR) issued are linked to the RF number.
QA plan: 1.3 [2]	Parts kits; Process Engineering: - How are kit lists created? - How are kit lists issued? - How do you know that the kit lists are accurate and complete? Material Control: - How are kits created? - How are kits issued?	☒	☐	☐	Kits lists are created off the approved and released drawings. Mainly the BOMs are used, but the parts are also cross-checked with developing the travelers. Parts kits are issued to Material Control to be filled. They are issued based on the production schedules. Material Control creates the kit, and sends the parts (and form) to MP9. The Traveler Coordinator “checks in” the kit by confirming that all requested parts are accounted for. Any discrepancies are immediately dealt with

Reference	*Criteria*	*Results* *Fully Sat*	 *Minor Issue*	 *Major Issue*	*Comments*
	- How do you know that the kits are accurate and complete?				and corrected. The final test for know that the kits are accurate and complete is by building chambers. The fact that there are no reported issues regarding missing parts indicates that the parts kits are accurate and complete.
QA plan: 7.3	Procurement; - How do you know what to buy? - Review drawings and technical specifications; - Vendor oversight, what did this entail?	☒	☐	☐	A Purchase Release (PR) or Engineering Release (ER) is generated to inform Acquisitioner what to purchase. The drawings used to procure parts must match the revision(s) indicated on the PR/ER. Vendor visits are performed for critical parts to assess the production status (i.e. on schedule and without problems) Process is straightforward and clearly understood.
QA plan: 6.0; EMU Design Handbook section 4.1.2.1	Design; - How do you know that are making meets the customer requirements? - How are the customer requirements defined? - How was the design validated against the requirements? - How are design changes handled? - How are drawings managed? - What has been done regarding product reliability?	☒	☐	☐	CMS Design Handbook was issued prior to TD involvement. The Handbook, along with input from the conceptual designers, was translated into a production design (output was released drawings and specifications). The design was reviewed during the Production Readiness Review. Engineering Design Reviews were done at CERN, and they focused on interfaces. Giorgio/Nelson did reliability calculations to define lifetime requirements for the electronic parts installed at TD. Prototype chambers were fabricated with production-type tooling. Fifteen chambers were tested on the cosmic ray stand here at Fermilab. All chambers are being tested on a cosmic ray stand at the FAST sites after all electronics have been installed. Drawings are managed through DCS, and copies are placed on the network for people to access over the internet. Configuration management is in place (i.e. there is a formal sign-off when the

TD-2002-01 CMS ME234/2 - Audit Checklist

Reference	*Criteria*	*Results* *Fully Sat*	*Minor Issue*	*Major Issue*	*Comments*
					configuration is set, and changes which affect design or interfaces are dispositioned by L2/L3 managers).
QA plan: 3.0	Quality Improvement; - What is being done to improve quality? - QCR reviews; - DR reviews;	☒	☐	☐	Examples of Discrepancy Report (DR) trending provided. Quality Control Report (QCR) trending had been done earlier in the project.
QA plan: 4.4.2	Records; - How are records managed? - Production records; - Inspection records; - What records are deliverable to the customer?	☒	☐	☐	All inspection records are going into the travelers. Electronic files are placed on the network. There is a clear process for completing the production & inspection records. When completed, all records are scanned and entered into the OnBase database in electronic format. Crosschecks have been implemented to verify that all of the required documents are scanned error free (i.e. the quantity of pages scanned must be in agreement with the quantity indicated on the Traveler). Person responsible for entering records has a thorough understanding of the process. The original Travelers are currently being retained at MP9. Right now hard copies of the Chamber Assy and Chamber Electrical Testing go with the chambers to the FAST sites. CMS at CERN has not defined any records requirements. All CMS production records are available over the internet via OnBase. "High level" drawings (e.g. assy drawings) are going to be loaded into EDMS at CERN.

Fermi National Accelerator Laboratory

United States Compact Muon Solenoid Collaboration

US-CMS CATHODE STRIP CHAMBER QUALITY ASSURANCE PLAN
Version 1

Approved, CMS-CSC Project FNAL Site Manager — 8/21/00 Date

Approved, CMS-CSC Project Engineer — 8/21/00 Date

Approved, Technical Division Head — 9/14/00 Date

Approved, Technical Division Quality Assurance Officer — 8/28/00 Date

Purpose

The purpose of this Quality Assurance Plan is to describe Fermilab's effort on the Cathode Strip Chamber portion of the Compact Muon Solenoid Project. This document is formatted following the criteria defined in DOE O 414.1A Quality Assurance, and the Technical Division Quality Management Program, TD-1.

Each section of this document begins with a policy statement for the Technical Division. The CMS-CSC Project adheres to the TD policies, unless otherwise stated.

Scope

The description and requirements in this plan are generally applicable to all activities included in the CSC portion of the CMS Project. All the detailed requirements that are specified in the TD Quality Management Program are not repeated here. The CMS Project Management has assigned the responsibility for execution of the CSC Project to the Technical Division.

1.0 Program

1.1 Policy

The policy of the Technical Division is to develop, document, and maintain it's quality management program, so that the Division may satisfy the needs of its customers.

1.2 Mission

The mission of *Fermi National Accelerator Laboratory* is:

"Advancing the understanding of the fundamental nature of matter and energy by providing leadership and resources for qualified researchers to conduct basic research at the frontiers of high energy physics and related disciplines."

The mission of the *Technical Division* is:

"The development, design, fabrication or procurement, and testing of accelerator and detector components."

The mission of the *Cathode Strip Chamber Project* at Fermilab is to:

1) Design, build, and test Cathode Strip Chambers;
2) Prepare component kits for assembly by other collaborating institutions;
3) Deliver compliant chambers to US Fast Sites for electronics integration.

1.3 Objectives, Goals and Functional Responsibilities

[1] To design and fabricate required detectors for the CERN LHC.

The Engineering & Fabrication Department is responsible for the design of the manufacturing tooling and the chambers that are required in this project.

[2] To procure, inspect, inventory, and deliver the various materials needed for this project.

The Material Control Department is responsible for these functions. The Engineering & Fabrication Department interfaces with the Material Control Department and other groups, as required, to assist the procurement section of Fermilab in procuring the needed material.

Inspection of the procured materials will be required. See section 8.0 for details. The storage and inventory of the components for the chambers may be required in some cases.

[3] To test the chambers.

All the detectors that are to be fabricated will be tested for functionality. See section 8.0 for specifics on Inspection and Acceptance Testing.

[4] To oversee the scheduling of milestones, to budget and control cost, and to report to the Level 3 manager timely status reports, as required by the project office.

These functions are assigned to the Fermilab CSC Site Manager & CSC Project Engineer, who are assisted by their staff and other project personnel. This includes reporting on the resource requirements and status of the project to the Technical Division Head.

[5] To create and maintain a Quality Assurance program.

Although quality is the responsibility of every Fermilab employee, the task of creating and maintaining the QA program is assigned to the Quality Assurance Officer.

[6] To perform the required material development for this project.

This task has been assigned to the Material Development Laboratory in the Engineering & Fabrication Department, on an as-needed basis.

[7] To provide a qualified staff for the performance of this project and to provide the needed laboratory work space.

This function is the responsibility of the Technical Division Head, acting on input supplied by the CSC Site Manager & CSC Project Engineer.

1.4 Organization Structure

Attached is the organizational chart for the CMS-CSC Project (see Attachment I). The organizational structure/responsibilities for collaborative groups, i.e. Universities of Florida and Wisconsin, are defined using Memorandums of Understanding (MoU's) and Statements of Work (SoW's). The signed approved original MoU’s and SoW's are maintained by the US-CMS project office.

Although the CMS Project is conducted as a collaborative team effort, the CMS-CSC Project Manager has ultimate responsibility for the completion of the project.

Clear and frequent communication is always encouraged among the project participants, and is critical to the success of the CMS-CSC Project. Informal communication via notes, phone calls, electronic mail, and informal discussions are exchanged frequently between the participants. This information flow encourages the exploration of the viability of plans and solutions, and allows for the resolution of any issues that arise. Although it is not a project requirement, the distribution of copies of informal correspondence to all participants is desirable to keep everyone apprised of the most current information available.

Management's systems for performing and assessing adequacy of work on the CMS-CSC's, including activities that relate to planning, scheduling, and cost control are described in detail in the following documents:

1. CMS Project Management Plan
2. Technical Division Quality Management Program
3. Technical Division Self-Assessment Program

1.5 Roles, Responsibility, and Authority

1.5.1 Project Site Manager, CSC Project

- Project Site Manager is responsible to the CMS Level 3 Manager for delivering acceptable chambers and chamber kits.
  - ♦ Manage the third level of the WBS for detectors with accepted Fermilab practices.
  - ♦ Record control account and schedule status on a timely basis.

- Represent the detector project to the collaborators and L3 and above, providing them, as required and funded, with resources, e.g. staffing, space, machine shop priority, et cetera.
- Ensure that requirements and specifications are provided to appropriate Technical Division groups on a timely basis.
- Implement the QA Plan.
- Assure the quality of the delivered products.

1.5.2 Engineering and Fabrication Department Head

Responsible for providing support, oversight, direction, and feedback to project managers.

1.5.3 Quality Assurance Officer

- Responsible for the creation and maintenance of the Quality Assurance Plan.
- Responsible for providing support to the CMS-CSC Project staff throughout the project.

1.5.4 Technical Division Head

Provide support to project personnel, and aid in solving problems that cannot be solved on a lower level.

1.6 Organizational Interface

1.6.1 CMS Project Office/TD-HQ

- Communicate project status when changes occur and periodic, e.g. monthly, reports.
- Determine staffing requirements for CMS-CSC Project within TD
- Resolve resource allocation issues, e.g. draftsman assignments, machine shop priorities, and space allocation.

1.6.2 CMS Project Office/Fermilab Business Office

- Procurement representative will attend weekly CMC-CSC design/fabrication meeting with CMS Project Managers and TD

1.6.3 CMS Project Office/Level II and Level III Managers

- Develop requirements and specifications to fulfill the goals of the CMS Project. The CMS Project Manager will approve requirements and specifications. Attachment III defines this interface.
- Conduct weekly meetings with Fermilab Business Manager and CMS Project Manager to discuss issues and procurement status

2.0 Personnel Training and Qualifications

2.1 Policy

The policy of the Technical Division is to hire and maintain personnel who posses the appropriate level of skill, experience, and academic qualifications to support the achievement of the CMC-CSC's mission.

2.2 Training

In-house training is provided to ensure that an appropriate level of skills, knowledge, expertise, and experience are available to accomplish the stated mission and objectives.

Training may come from several sources such as mentoring provided by physicists, engineers, supervisors, lead personnel, consulting firms, technical operating manuals, and other sources. Job-related training records of all assigned personnel, for work related to the CMS Project, are maintained by the respective supporting organization.

2.3 Qualifications

Qualifications for personnel working on the CMS are based upon the responsibilities of the position and project needs, which define the level of education, extent of work experience, knowledge and specific skill requirements.

3.0 Quality Improvement

3.1 Policy

The policy of the Technical Division is to continuously improve in all areas and activities for which it is responsible.

3.2 Quality Implementation

- This document is the guide for the development and implementation of quality assurance for the CMS-CSC Project, and is used to support the achievement of the stated mission and performance objectives. This document further ensures that appropriate procedures are in place that describes the extent and method of how the quality requirements will be implemented.
- It is the intent of the CMS Project Manager that all activities be performed at a level of quality appropriate to achieving the scientific, technical, operational, and administrative objectives.

3.3 Quality Responsibilities

- All personnel performing a function at Fermilab are responsible for quality and are encouraged to promptly report conditions adverse to quality such as deviations, deficiencies, failures, defective items or processes, and nonconformances, to the appropriate level of management.
- Personnel closest to the daily operation or activity are in the best position to understand and report nonconforming conditions, and are encouraged to participate in quality improvements to meet the needs of the customer and to achieve the objectives of the project mission.
- Strong emphasis is placed on line supervision leadership, accountability, and the implementation of quality tools at the line level.
- Management is responsible for providing the necessary resources for conducting root cause analysis and for implementing corrective and preventive actions.

3.4 Performance Cause Analysis

3.4.1 Supplier Performance

Supplier performance problems are identified and reported through the mechanism of Quality Control Reports (QCRs), generated by the Material Control Department's Incoming Inspection group for items such as incoming parts, assemblies, and supplied purchased hardware. These reports are reviewed and approved by the responsible authority/physicist (or designee) of the area or activity in which they will be used and by the

Material Control Department Head (or designee). The review will cover problems that may have significant programmatic effect or risk factors affecting cost, schedule, ES&H (personnel safety), or configuration. The appropriate disposition is given, i.e. scrap, return to vendor for replacement, rework at vendor, rework in house, or use as is. These reports are reviewed for supplier performance problems or trends and are used as a basis for cause analysis and necessary corrective action.

3.4.2 Work Process Performance

Discrepancy Reports have been developed and implemented to document problems during assembly or fabrication such as deviations, deficiencies, failures, defective items/materials or processes, malfunctions, trends, and/or non-conforming conditions.

The responsible authority of the activity or area of occurrence reviews these discrepancy reports for technical evaluation, cause determination, disposition, and corrective/preventive action recommendation.

Process Engineering performs a review of these reports to ensure that reports are completed properly and that preventive action is adequate; the QA Manager may also recommend follow up corrective/preventive action or verification/validation as required. These discrepancy reports are used as a basis for trends, cause analysis, and/or lessons learned.

4.0 Documents and Records

4.1 Policy

The policy of the Technical Division is to maintain adequate documentation and records to ensure quality requirements are met, while recognizing the objective of minimizing paperwork and cost.

4.2 Controlled Documents

4.2.1 Controlled documents are created, implemented, and maintained at a level commensurate with the level of work being performed and as dictated by sound quality assurance practices.

4.2.2 The TD maintains the following documents under document control:

- CMS-CSC Quality Assurance Plan
- Released Engineering Drawings and Technical Specifications
- Quality Control Travelers

4.3 Documents and Records Responsibilities

4.3.1 Quality Assurance is responsible for the release, revision, and distribution of the CSC QA Plan.

4.3.2 The Engineering and Fabrication department is responsible for the control of documents and data pertaining to engineering specifications, engineering procedures, drawings, and Quality Control Travelers; and for the control of documents and data regarding CSC testing.

4.3.3 The Material Control Department is responsible for the control of documents and data associated with the procurement of materials for the assembly of the chambers.

4.4 Documents and Records Procedures

4.4.1 All controlled documents:

1. Are reviewed and approved by authorized personnel prior to being issued/revised.
2. Have a revision history maintained.
3. Are available to all personnel who need access.

4.4.2 All records are maintained in accordance with the Fermilab Records Management Program (based on DOE Order 1324.5B).

5.0 Work Processes

5.1 Policy

The Technical Division's policy is that work processes be well thought out, appropriately documented and reviewed, and that they be carried out by competent and effective workers.

5.2 Responsibility

5.2.1 The CSC Project Site Manager's responsibility, as defined in 1.5.1, includes administering, planning, organizing, and controlling the CSC Project to meet the project technical, cost, and schedule objectives. In particular, the CSC Project Site Manager strives to encourage effective human resource management with the goals of hiring and maintaining an efficient and effective work force.

5.2.2 The individual CSC worker is the first line in ensuring quality. They are responsible for following the procedures defining the assembly and quality control checks in the fabrication of the chambers, i.e. Quality Control Travelers. They also have the authority to report any possible nonconformities to management, and may participate in cause analysis and continuous improvement.

5.2.3 The Department Heads are responsible for ensuring that people who assigned to tasks have the appropriate academic qualifications, professional certifications, or skills and experience to carry out the work successfully.

5.2.4 The CSC Project Site Manage, the CSC Project Engineer, and other project staff, as appropriate, are responsible for planning, authorizing, and specifying (to an appropriate level of detail), the conditions under which work is to be performed. This includes the calibration of measuring and test equipment (see section 8). This group also specifies which work is sufficiently complex or involves sufficient hazard to be performed to written procedures.

5.2.5 The Engineering & Fabrication Department is responsible for the inspection and test status, identification and traceability, and for the creation and maintenance of the QCTs for the chambers (see 5.4).

5.2.6 The Material Control and Engineering & Fabrication Departments share responsibility for the handling, storage, and preservation of chamber components and completed chambers.

5.3 Production Process Control

Attachment IV defines the workflow for the fabrication of the chambers.

The EF Department Head, in conjunction with the CSC Site Manager and CSC Project Engineer, is responsible for ensuring that production processes are carried out under controlled conditions. When planning the production processes, the following are considered:

- All applicable government safety and environmental regulations
- Use of QCTs (or other such work instructions) to document the methods of production. These should be used when the absence of such procedures could be adverse to quality.
- Defining suitable equipment and work environment to ensure quality.
- Defining suitable maintenance of equipment to ensure continuing process capability.
- Defining the criteria for workmanship in the clearest practical manner. Examples of this are work instructions that document tolerances for process parameters, samples or pictures of "quality" product, samples or pictures of poor quality or failure modes to look for.
- Level of education and experience required for production operators.
- Training needs for production operators.

5.4 Quality Control Travelers (QCT's)

A system of Quality Control Travelers is used to define the sequence of fabrication, inspection, and testing to be performed for the chambers. Witness/Hold points are designated in QCT's at a turning point or important juncture of the fabrication. QCT's provide for sign-off by qualified personnel and are dated at the completion of each fabrication sequence, welding operation, and inspection/test procedure by designated inspection/test personnel, fabrication personnel, or welding personnel to assure completion, date completed, and sequence of required operations.

Training of project personnel in the usage of QCT's is accomplished with a "walk-thru". The "walk-thru" training is conducted and documented by Process Engineering. The initial training simulates an actual operation (e.g. panel winding) using the QCT in a step by step sequence. The goal of the initial training is to familiarize all personnel with the proper usage of QCT's in general, as well as to help everyone understand how the particular operation is designed to be completed.

Subsequent training of QCT revisions may be accomplished by routing the revised QCT to the appropriate personnel for signature, signifying that the revised QCT has been read and understood.

6.0 Design

6.1 Policy

The policy of the Technical Division is to ensure that designs perform as intended. This is accomplished by incorporating sound engineering/scientific principles and appropriate technical standards into designs.

6.2 Requirements

The CSC Project Site Manager and CSC Project Engineer implement the design policy. The CMS Title I Design Report (the CMS design handbook) has been independently reviewed in order to assure compliance with this policy.

The chambers fabricated at Fermilab must fulfill the requirements defined in the CMS design handbook. Any changes to the chamber design, as defined in the handbook, must be reviewed and approved by the appropriate level of management (see section 8 of the US-CMS Project Management Plan, Project Management System).

6.3 Drawings and Specifications

Formal drawings are generated and stored through the Engineering and Fabrication Department, and these drawings are reviewed and approved by the appropriate level of management.

6.4 Design Reviews

At appropriate stages of design, formal documented reviews of the design results are planned and conducted. Participants at each review include representatives of all functions concerned with the design stage being reviewed, as well as other qualified personnel (this may include ES&H). These reviews are completed in order to:

1) Identify potential problem areas or inadequacies;
2) Assess issues affecting safety and quality;
3) Initiate corrective/preventive actions;
4) Ensure that the design minimizes ES&H impact and satisfies all FNAL ES&H policies and external codes.

Results from the reviews are used as a basis for verifying that design stage outputs meet the design stage input requirements.

6.5 Design Validation

Designs are validated through the testing of the complete prototype system (or subsystem) during and after assembly, against the performance specifications. This testing includes the utilization of a cosmic ray test stand.

6.6 Design Changes

Appropriate design controls are incorporated into the CSC project by using configuration management. The change management mechanism, defined in section 8 of the US-CMS Project Management Plan, is used by the CSC project.

Proposed changes that affect the life, performance, reliability, or integration with other sub-systems, are reviewed and dispositioned by the Configuration Control Group (L2 and L3 managers). In order for the new design to be approved, the initiator must convincingly demonstrate that either the old design is not adequate, or that the new design has superior performance and/or cost advantage(s) over the old.

7.0 Procurement

7.1 Policy

The Technical Division policy is to ensure that items and services provided by suppliers meets the requirements and expectations of the end-users.

7.2 Requirements

The Fermilab contract with the DOE specifies a variety of management controls to be applied to procurements and sub-contracts through the applicable DOE orders, DOE Acquisition Regulations (DEAR), and Federal Acquisition Regulations (FAR). To this end, all procurement activities are performed in accordance with the *Fermilab Procurement Policy and Procedures Manual* and the *Fermilab ES&H Manual*.

Only approved material will be used in the production of the CSC's. The Material Control Department has the responsibility of procurement for the Technical Division and the CMS-CSC project.

7.3 Supplier Qualification and Selection

Suppliers are evaluated and selected on the basis of their ability to meet subcontract requirements. These requirements are appropriately defined in approved Engineering Drawings and Technical Specifications, and include specific quality assurance requirements.

Topics that are usually evaluated include, but are not limited to:

- Quality assurance program
- Ability to meet all requirements
- Cost
- Financial solvency
- Work history

7.4 Budget Authority

The Division Head, in conjunction with the budget defined by the CMS Project Office, assigns expenditure level to individuals responsible for a specific work package. Procurement of items and services that are above the stated expenditure level require Division Head review and approval. Attachment II defines proposed expenditure levels.

8.0 Inspection and Acceptance Testing

8.1 Policy

The Technical Division policy is to ensure that all items, components, and services meet the specified requirements. This is verified through the use of inspection and acceptance testing.

8.2 Requirements

As defined in section 5.2.4, the CSC Project Site Manager and the CSC Project Engineer define the types of work that require formal inspections and acceptance testing. When an inspection or acceptance test is performed, the characteristics and processes to be inspected or tested, the inspection techniques to be used, the hold points, and the acceptance criteria are defined, as appropriate.

Inspection and acceptance testing (to include receiving, in-process, and final) are performed in accordance with proper training and/or written procedures.

The Material Control Department works with the CSC Project Engineer to define and document receiving acceptance testing for incoming materials. The Quality Control Traveler defines the testing during the assembly of the chambers (in-process). The final inspection will include a sample of chambers undergoing testing in a cosmic ray test stand.

Properly calibrated (traceable to NIST) and maintained measuring and test equipment are used for all testing.

8.3 Records

To allow for traceability, adequate records are maintained for all inspections and tests. These records include observations made, inspection/test results, identification of the personnel conducting the inspection/test, date, and time.

9.0 Management Assessment

9.1 Policy

The Technical Division's policy is to regular assess the Division's effectiveness in meeting it's objectives, goals, and compliance to orders and regulations. This is accomplished using the Technical Division Self-Assessment Program.

9.2 Requirements

Technical Division management will evaluate the TD's role in the CMS Project, in order to ensure the Division's continuing suitability in fulfilling the requirements of the CMS Project.

9.3 Methods

Details from the TD Self-Assessment Program are not repeated here. Assessments are made using formal and informal meetings and other communications. Examples are:

- Division Head meeting with Department Heads or other supervisory staff
- Department Heads meeting with line supervisors and other lead personnel
- Suggestions and recommendations from project personnel
- Design Reviews & Production Readiness Reviews
- Independent assessments (see Section 10.0)

9.4 Feedback

Information gathered during management assessments is used to provide feedback to the CMS Project personnel. This information will allow project personnel to make improvements and any necessary corrective/preventive actions, so that the goals of the CMS Project may be met.

10.0 Independent Assessment

10.1 Policy

The policy of the Technical Division is to utilize independent, i.e. third party, audits to ensure the Division's effectiveness in meeting it's objectives, goals, and compliance to orders and regulations.

10.2 Requirements

The CMS Project will be audited and evaluated by a third party, as needed. The audit(s) are used to insure that the quality management system is effective in achieving the stated mission.

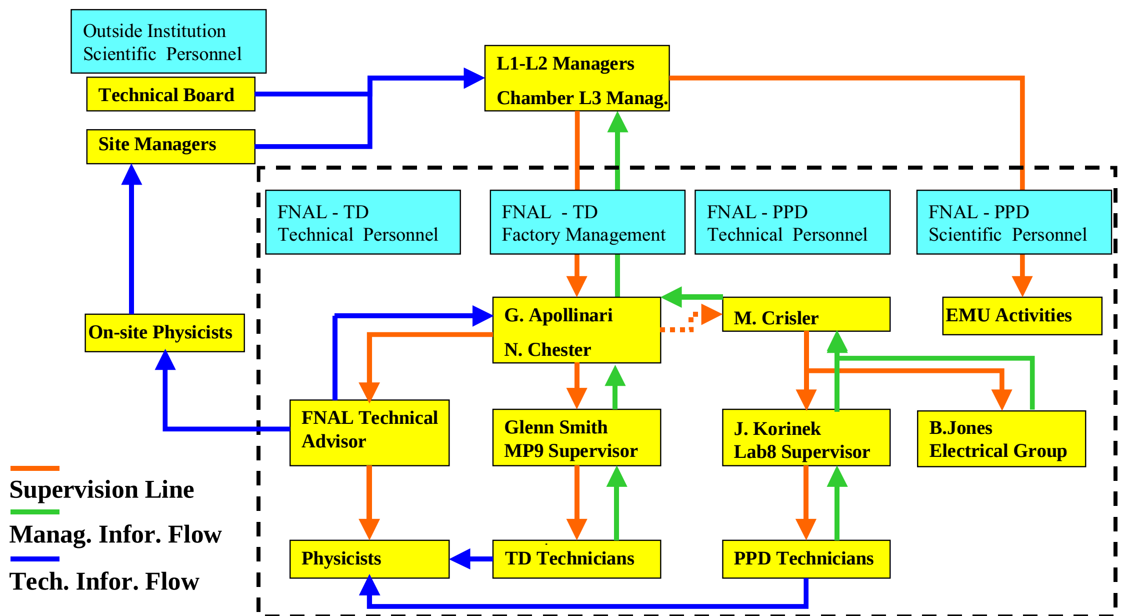
In order to evaluate the quality management system on a regular basis, an audit plan will be created and implemented by management. When performing the audits competent technical personnel will be utilized as auditors. These auditors are independent of the specific activities or areas being audited. Management, having responsibility in the area audited, and to assure corrective action and involvement of personnel of the specific areas of the audit, will review documented audit results.

10.3 Responsibilities

The Quality Assurance Officer is responsible for coordinating independent assessments and, as team leader and spokesperson, will provide leadership, guidance, audit procedures, and audit plans.

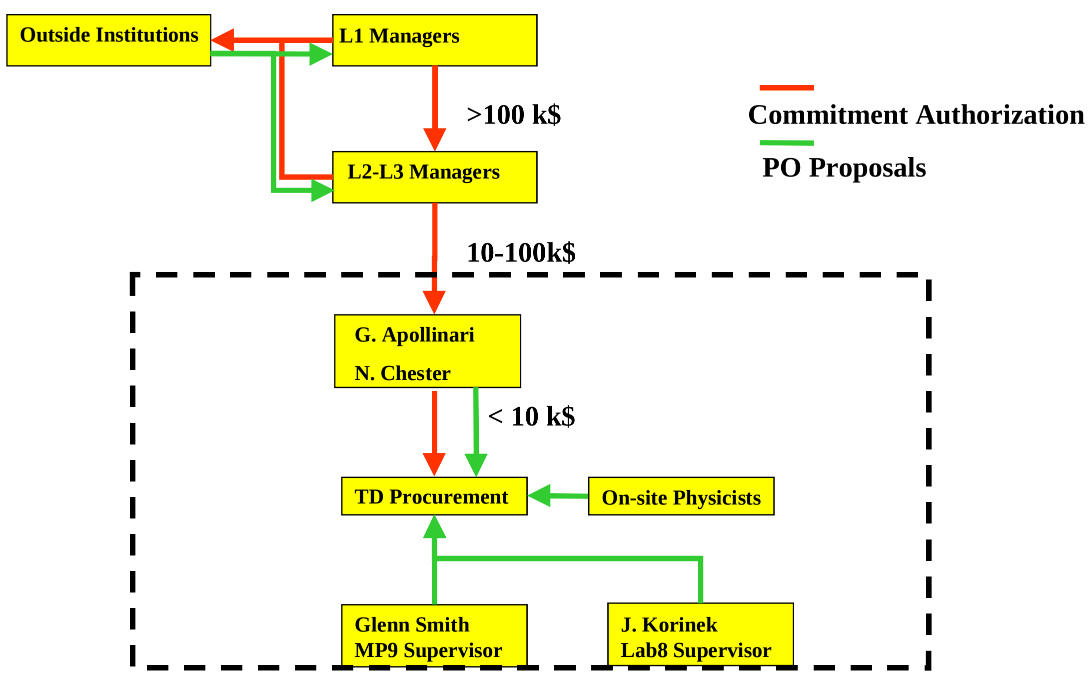
ATTACHMENT I

EMU Chambers Production Supervision Lines @ FNAL



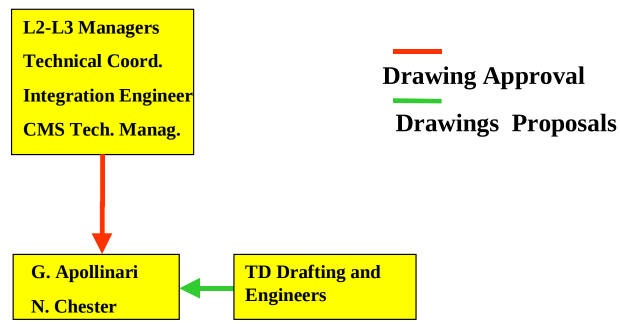
ATTACHMENT II

EMU Chambers Production
Commitment Authorization
PO Proposal



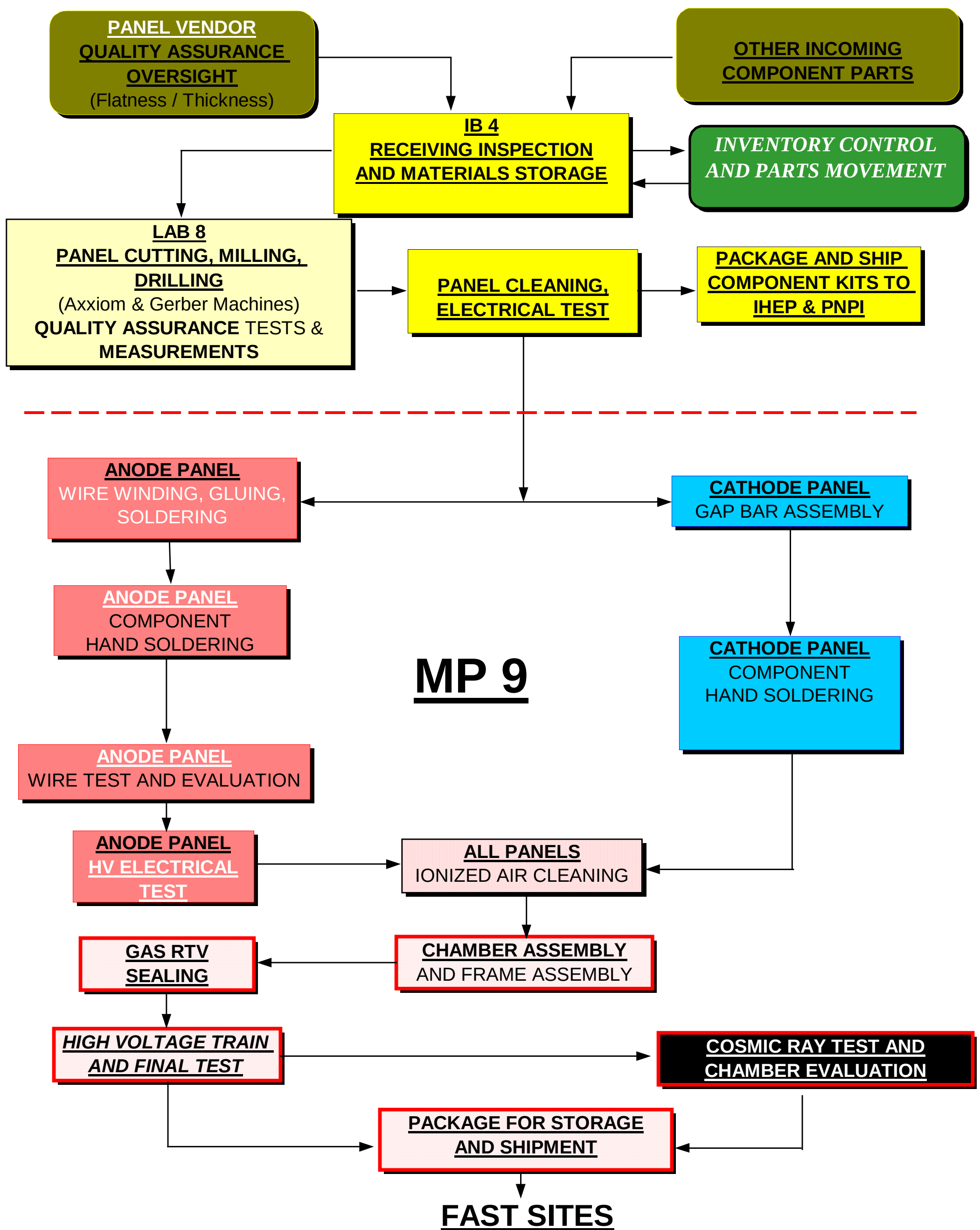
ATTACHMENT III

EMU Chambers Production Drawings Approval



ATTACHMENT IV

Fermilab Plan
CMS Muon Chamber Production
Production Flow



Revision History

Version	Date	Section No.	Specifics
1	08/18/2000	All	First version

Controlled Distribution

Technical Division library	
CMS-CSC FNAL Site Manager	Giorgio Apollinari
CMS-CSC Project Engineer	Nelson Chester
Technical Division Quality Assurance Officer	Jamie Blowers

Table 4.1.1
Chamber parameters.

Parameter	ME1/1	ME1/2	ME1/3	ME2/1	ME3/1	ME4/1	ME234/2
Basic single plane parameters							
full gas gap (2h), mm	6	9.5					
wire diameter, μm	30	50					
wire spacing, mm	2.5	3.16	3.16	3.12	3.12	3.12	3.16
Active area							
width (top), mm	487	819	933	1254	1254	1254	1270
width (bottom), mm	201	511	630	534	617	685	666
length, mm	1505	1635	1735	1900	1680	1500	3215
Wires							
wire tilt	25°	0°					
wires per plane	600	528	560	620	550	492	1028
wires per wire group	11-12	11	12	5, 6	5, 6	5	16
wire group width, mm	27.5-30	35	38	16, 19	16, 19	16	51
wire group cap., pF	60-150	40-70	50-80	20-60	20-60	25-45	80-150
wire channels per plane	48	48	48	112	96	96	64
Strips							
Δφ(single strip), mrad	2.96	2.33	2.16	4.65	4.65	4.65	2.33
width (top), mm	7.6	10.4	14.9	15.6	15.6	15.6	16.0
width (bottom), mm	3.15	6.6	11.1	6.8	7.8	8.6	8.5
gap between strips, mm	0.35	0.5					
strip capacitance, pF	90-140	110	145	145	130	120	250
radial split of strips	@η=2.0	none					
strip channels per plane	2x64	80	64	80	80	80	80
HV							
Operating HV [kV]	~3.0	4.1					
HV segments per plane	1 or 2	2	3	3	3	3	5
Overall chamber parameters							
Number of chambers	72	72	72	36	36	36	216
Planes/chamber	6						
φ-coverage, degrees	10°	10°	10°	20°	20°	20°	10°
φ-overlap, strips	5	5	none	5	5	5	5
η-coverage	1.5-2.4	1.2-1.6	0.9-1.1	1.6-2.4	1.75-2.4	1.85-2.4	varies
η-overlap	none						
Length, mm	1680	1800	1900	2065	1845	1665	3380
Width (top), mm	613	1078	1192	1534	1534	1534	1530
Width (bottom), mm	311	740	859	751	835	903	895
Chamber thickness, mm	148	250					
Chamber weight, kg	~60	150	160	190	180	160	276

4.1.2 Special conditions and requirements

4.1.2.1 Reliability

Given the scale of the system, the primary concern is obviously its reliability. The system must be designed so that, once commissioned, it will require a minimum of maintenance and repairs. We have paid particular attention to wire strength and fixation, HV segmentation, gas tightness, and chamber rigidity and stability.

4.1.2.2 Off-line spatial resolution: φ-coordinate

Detailed Monte Carlo studies have been performed to identify the required CSC spatial resolution [4.4]. The optimization was done by requiring that the chamber spatial resolution contribution to the precision of muon momentum measurement (standalone muon system) be less or comparable to the contribution of multiple scattering. Muons with p_T<100 GeV were chosen as a reference since this range of momenta covers most of the plausible physics processes. The outcome of the analysis is the 75 μm requirement for the ME1/1 and ME1/2 chambers and 150 μm for the others (both numbers refer to resolution per six-plane package). Prototype results show that this goal is well within reach (see subsection 4.8.2.1).

4.1.2.3 Off-line spatial resolution: r-coordinate

To reconstruct the muon p_T or p, one needs to know the radial position of hits. High background rates impose an additional requirement on the maximum width of the anode wire groups. Radial resolution also affects efficiency of finding a muon track in the tracker by tracing it backward from the muon system. An additional constraint is wire group capacitance, which should remain sufficiently small to ensure high precision of time measurements. Optimization among all of the above requirements leads to the choice of wire group segmentation as specified in Table 4.1.1. Wire group hits are read out in yes/no mode every 25 ns, and thus the radial spatial resolution per plane is defined by the wire group width.

4.1.2.4 Magnetic field

The map of magnetic field shows that the ME1/1 chambers will have to operate in an axial magnetic field ranging from 2.7 to 3.1 T. The effect of such a field cannot be fully compensated by tilting the wires but can be minimized to an acceptable level. The ME1/2 chambers, on the other hand, will be placed in a highly non-uniform field of up to 1.2 T which will inevitably affect their resolution. However, their performance remains within our specifications despite this deterioration. Some of the other chambers will also experience quite noticeable magnetic fields. Discussion of how the B-field affects the CSC spatial resolution, and results of prototype tests and simulation, can be found in subsection 4.8.2.2 and 4.9.

4.1.2.5 Background rates

Backgrounds and shielding issues are discussed in section 1.4. There are four major sources of background hits:

- random hits induced by neutrons/gammas,
- punchthrough and pi/K in-flight decays,
- tunnel muons,
- e/m debris associated with energetic muons going through matter, e.g., calorimeter, iron disks, etc.

The rate of random hits is largest and goes as high as 1000 Hz/cm^2 in the bottom area of the ME1/1 chambers. Although the rate per plane is very high, hits rarely penetrate more than a few planes [4.5], so that this background can be suppressed by having multilayer chambers.

Experimental results and simulation have shown that six-plane chambers with a requirement of having 4 out of 6 planes hit will provide sufficiently robust performance (see sections 4.8.4 and 4.8.5).

The rate of punchthrough background reaches about 300 Hz/cm^2 in the worst spots. The danger of punchthrough is that the charged particles will get through the entire six-plane chamber.

The rate of tunnel muons is in the range of a few Hz/cm^2. Although this is relatively low, the hits induced by these muons in the φ-coordinate view appear as if they were produced by muons coming from the IP with infinite momentum. Thus this background is a primary concern for the trigger. The capability of the chamber of pointing back to the IP (θ-angle) is of critical importance for suppressing these fake triggers.

The last source of background (muon Bremsstrahlung) will compromise track measurements with a few percent probability per station. If one requires high precision measurement, this can reach almost 10% (for details see subsection 4.8.4). It is worthwhile mentioning that this background is associated with real muons themselves and is therefore luminosity independent.

4.1.2.6 Aging

High hit rates up to 1000 Hz/cm^2 raise a question of chamber aging due to gas polymerization on wires or cathodes. The baseline operational point corresponds to a charge per avalanche of about 100 fC, as seen by the fast cathode pre-amplifiers, which have a shaping time of 100 ns. This corresponds to about 1 pC total charge released in an avalanche. Assuming that one year of LHC operation corresponds to $3{\cdot}10^7$ seconds, one immediately estimates that the total accumulated charge on wires in 10 years of operation at the full LHC luminosity will be 0.1 C/cm. The results of aging tests (see subsection 4.8) show that this number results in a very good safety margin, provided that CF_4 gas is present in the mixture.

4.1.2.7 Trigger: r-coordinate and timing

A track stub in the wire readout side of a CSC is recognised when at least 4 planes have hit wire groups which line up in a pattern consistent with a track pointing back to the IP. The time measurement from a single plane has a spread exceeding the 25 ns window and, therefore, a single plane cannot provide a reliable bunch crossing identification. However, one can take advantage of multiple planes in a chamber: prototype tests show that by taking the second or third earliest hit out of six hits in a pattern, one can achieve a very high efficiency in tagging the bunch crossing (see subsection 4.8.5). The earliest hit out of six also has a very narrow distribution, but this scheme would be very vulnerable to random hit backgrounds. Once all four local track stubs found in chambers are linked to form a muon track, one can take the most frequent bunch crossing ID (out of the four linked stubs) as the bunch crossing ID for the track. In this scheme, one obtains the correct bunch crossing assignment more than 99% of the time, if the individual chambers provide the correct identification with 92% probability or better. This goal is well within the CSC reach (see subsection 4.8.3 and 4.8.5).

4.1.2.8 Trigger: φ-coordinate precision

Trigger rates simulation shows that one needs to have about 30% momentum resolution at the L1 trigger up to p_T of around 50 GeV. This ensures sufficient sharpness of the trigger turn-on curves and thus makes it possible to control the trigger rate, should the background problems turn out to be worse than anticipated. To achieve 30% momentum resolution, one would need to localize muon hits within about a half-strip width per chamber plane. Hardware implementation to provide half-strip digitization at the trigger level will be discussed in subsection 4.4. Prototype tests proved the capabilities of this approach (see subsections 4.8.2.3 and 4.8.3.2). Using muon hits localized to within a half-strip per plane, special trigger logic will look for patterns of hits consistent with the passage of muons of interest.

4.2 DETAILED CHAMBER DESIGN: ME1/2, ME1/3, ME234/1, ME234/2

4.2.1 Introduction

This section covers the design of the seven types of EMU CSCs, ME1/2, ME1/3, ME2/1, ME3/1, ME4/1, ME234/2, the total number of which is 468. Although being very different in terms of size, number of readout channels and resolution requirements, the basic design grounds for all these chambers are essentially the same. An exploded side view of a CMS Endcap Cathode Strip Chamber, identifying all the major chamber components, is shown in Fig. 4.2.1. Seven panels are stacked together to form six gas gaps. Six out of the seven panels carry strip artwork on one side (strips face up in the drawing), the other side being a smooth uninterrupted ground.

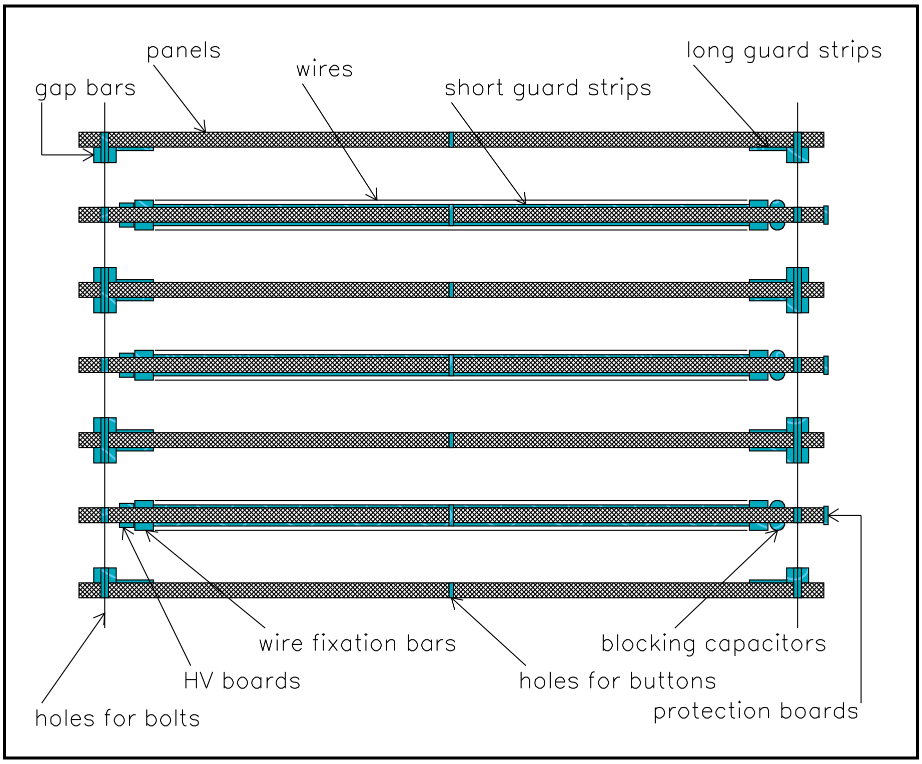


Fig. 4.2.1: Exploded view of a cathode strip chamber (not to scale) showing its main components and the way the chamber is assembled.

Anode wires are wound onto both sides of the three panels called *anode panels*. Naturally, these panels also carry artwork for taking anode signals out at one side of the panels and for feeding high voltage in at the opposite side (HV is applied to the wires). The wires are

8. US CMS Project Management System

8.1 Introduction

The CMS Project uses the work breakdown structure described in Chapter 5 as a framework for preparing a detailed cost estimate and a resource-loaded schedule. The work breakdown structure dictionary provides the initial input for the technical scope baseline given in Appendix 2. The time phasing of the resource-loaded schedule has been adjusted to fit within the anticipated funding profile. This then forms the basis for the cost baseline or budget shown in Appendix 4. This system is described in more detail in a US CMS project office procedure.

8.2 Change Control, Change Authorization and Contingency Management

The US CMS Fermilab construction project manager and technical director will control changes in requirements, cost, and schedule (in consultation and agreement, as appropriate, with the US CMS project management group). Any change that affects the interaction between detector subsystems or that significantly affect the performance, schedule, or the safety of the detector must also be referred to the CMS Management Board by the construction project manager and technical director.

DOE and NSF will make funds available for support of the US CMS Project on an annual basis. Each year the construction project manager and technical director review, negotiate, and approve the Statement of Work which will include a description of the work to be performed, the requested funds, and the manpower to be assigned to that year's activities. Also, through reviews, the projected cost of the work, and the currently projected contingency requirement at work breakdown structure level 3 over the life of the project will be known. Funds will then be released to the institutions that are part of the US CMS Collaboration. A management reserve will be held by the construction project manager and will be applied during the fiscal year on the basis of performance and need, following the principles of change control outlined below.

The Project Management Group, chaired by the Fermilab deputy director, will act as a high level Change Control Board for the US CMS Project. The Project Management Group will have as its purview assignment of contingency funds, changes of the scope of the project, and changes to the schedule exceeding thresholds shown in Appendix 6. Scope reductions may be required should projected costs of any level 2 subsystem greatly exceed the budgets to complete.

Formal change requests will be submitted and dispositioned (either approved or disapproved) for all changes exceeding thresholds stated in Appendix 6. The Project Office will maintain a record of all change requests. A *de minimus* level for cost changes is set at $1,000.

The principles of contingency management that the US CMS Project will follow are as follows:

- The cost estimate for each level 2 subsystem will include a contingency estimate based on an assessment of uncertainties and risks associated with the budgeted cost.
- Actual expenditure of contingency will be reflected in a revised estimate at completion, updated at least annually.

The Fermilab US CMS Project Management Group will consider and approve or disapprove all change requests that trigger the threshold set in Appendix 6. The US CMS Project Office will maintain a log of such approved (at any level) change requests. This log will be available for review by all project management.

- All cost changes to the baseline costs shall be traceable.
- The construction project manager must approve in advance all procurements requiring the use of contingency.

Appendix 6: Proposed US CMS Project Management Change Control Thresholds

	Level 0	Level 1	Level 2	Level 3a	Level 3b
	DOE Director of Energy Research /NSF Director of Mathematical and Physical Sciences	DOE/NSF Joint Oversight Group	DOE/NSF (Agency) Project Manager	Fermilab Deputy Director	US CMS Technical Director & Construction Project Manager
Technical	Changes that require modification to the US/CERN Agreement and Experiments Protocol	Approve the technical baseline as described in Appendix 2: US CMS Technical Baseline Document.	Significant changes to the technical baseline as described in Appendix 2: US CMS Technical Baseline Document.	Any change in scope that has a significant impact on the physics performance of a sub-detector, including trade-offs among subdetectors Significant changes in scope or detailed design of sub-detectors.	Any change in scope or physics performance of a subdetector, including trade-offs among subdetectors. Changes in scope or detailed design of subdetectors as documented in the Design Handbook.
Schedule	Changes that require modification to the US/CERN Agreement and Experiments Protocol.	Greater than six month change in a Level 1 milestone. [Appendix 3: US CMS Baseline Schedule.]	Greater than three month change in a Level 2 milestone. [Appendix 3: US CMS Baseline Schedule.]	Greater than three month change in a Level 2 milestone. [Appendix 3: US CMS Baseline Schedule.]	Greater than a one month change in a Level 2 milestone. [Appendix 3: US CMS Baseline Schedule.] Greater than one month change to milestones defined by the CPM and TD.
Cost	Changes that require modification to the US/CERN Agreement and Experiments Protocol.	Any change to the US CMS Total Project Cost (TPC).	Cumulative changes greater than $2.5 million to the US CMS cost baseline at WBS Level 2. [Appendix 4: US CMS Cost Baseline.]	Cumulative changes greater than $1.0 million to the US CMS cost baseline at WBS Level 2. [Appendix 4: US CMS Cost Baseline.]	Cumulative changes in the cost baseline of $100 thousand at WBS Level 2. [US CMS Cost Estimate dated May 1998.]

Statement of Work

by

the US CMS Group at Fermilab

for Activities Related to the US CMS Endcap Muon Subsystem

During Fiscal Year 2002

March 20, 2002

1. Introduction

This Statement of Work (SOW) is made to provide the yearly details of the work agreed to between the US CMS Project and the US CMS group at Fermilab. It covers the specific period of performance from October 1, 2001 through September 30, 2002.

2. Personnel

2.1. List of Scientific Personnel

Participating scientists with anticipated fraction of their research time committed to CMS during this period of performance are listed below. No support for these individuals comes from project funds.

Name	CMS Fraction	Other Research Commitments/Comments
G. Apollinari	80%	CDF (20%)
D. Eartly	100%	
R. H. Lee	66%	
K. Maeshima	50%	
O. Prokofiev	100%	

2.2. List of Technical Personnel

Participating technical personnel with the anticipated fraction of their time (time fractions are estimates and are not cost shares) committed to CMS during this period of performance and their source(s) of support are indicated below. The possible sources are DUS = DOE, US CMS Project; NUS = NSF, US CMS Project; DBG = DOE base grant; NBG = NSF base grant, UID = university infrastructure, DOE-supported group; and UIN = university infrastructure, NSF-supported group as shown in the WBS. The WBS numbers at L7 to which the salary costs should be charged should be filled in with the appropriate fraction of the salary charge if this cost is covered by a grant supplement. The cost on the CMS Project will be assigned algorithmically in the case of a grant supplement, That cost will be assigned to the WBS numbers given below with a weight equal to the salary fraction. The sum of the salary fractions should equal one.

Engineers

Name	CMS Fraction (%)	Cost on CMS Project this FY (k$)	Source of Support	WBS #'s	Salary fraction
N. Chester	100%	AAA$	DOE	1.8.2.2	100%
J. Brandt	25%	BBB$	DOE	1.8.1.1.7.2	100%
V. Razmyslovich	50%	CCC$	DOE	1.8.1.1.7.7	100%
V. Sknar (alignment)	25%	-	CMS Visitor	1.7.7.5, 1,7,6,8	-

Designers

Name	CMS Fraction (%)	Cost on CMS Project this FY (k$)	Source of Support	WBS #'s	Salary fraction
P. Belko	25%	DDD$	DOE	1.8.1.1.7.2	100%

Technical Specialists

Name	CMS Fracti on (%)	Cost on CMS Project this FY (k$)	Source of Support	WBS #'s	Salary fraction
P. Deering (Lab 8 Supervisor)	50%	-	Base Program	-	50%
Lab 8 Technicians (3.2 techs)	100%	EEE$	DOE	1.8.4.2.9.5	100%
G.Smith (MP9 Supervisor)	100%	FFF$	DOE	1.8.4.3.1	100%
J. Wittenkeller (MP9 Lead)	100%	GGG$	DOE	1.8.4.3.8.8	
MP9 Technicians (6 techs)	100%	HHH$	DOE	1.8.4.3.8.9	100%
Documentation/Travelers (1.2 techs)	100%	III$	DOE	1.8.1.1.7.1.4	100%
Inspection (0.2 techs)	100%	JJJ$	DOE	1.8.3.1.1.4	20%
Chamber Parts Shipment (0.6 techs)	100%	KKK$	DOE	1.8.3.1.2.3	60%
Integration Parts Shipment (0.3 techs)	100%	LLL$	DOE	1.6.2.1.8	30%

Programmers

Name	CMS Fraction (%)	Cost on CMS Project this FY (k$)	Source of Support	WBS #'s	Salary fraction
E. Orischin (alignment)	25	-	CMS Visitor	1.7.5.5.2	-

Others

Name	CMS Fraction (%)	Cost on CMS Project (k$)	Source of Support	WBS #'s	Salary fraction

3. Responsibilities for this Period of Performance

3.1 WBS Items at L7, Estimated Cost and Deliverable

During this period of performance the US CMS group at Fermilab agrees to supply the following deliverables at a cost not to exceed the estimated base cost given in the US CMS WBS. The following itemized list describes the items (or partial completion of items) provided in this period (Statements of Work).

WBS (L7)	Task - Deliverable	WBS Base Cost (FY00$)	FY02 Cost (FY02$)	FNAL MPO	DOE Suppl.	NSF
1.1.3.1	Physicist in charge for production at Fermilab	0	0	0		0
1.6.2.1.3	procure Cu pads	270,100	0	0		0
1.6.2.1.8.2	ship On-chamber parts to PNPI FY02	15,199	15,984	15,984		0
1.6.2.1.8.4	ship On-chamber parts to IHEP FY02	15,199	15,984	15,984		0
1.6.2.1.8.5	Ship On-chamber Electronics to Dubna (ME11)	14,000	14,723	14,723		0
1.6.2.1.8.6	Labor for shipment parts to Dubna (ME11)	10,000	10,516	10,516		0
1.6.2.1.8.7	Labor for shipment on-chamber parts to PNPI & IHEP	34,000	35,756	35,756		0
1.7.8.2.3.2	test & calib.	1,500	1,577	0		1,577
1.7.8.2.4.4	test & calib.	3,750	3,944	0		3,944
1.7.8.2.5.2	test & calib.	3,000	3,155	0		3,155
1.7.8.2.6.2	test & calib.	1,950	2,051	0		2,051
1.7.8.2.7.3	test & calib.	1,950	2,051	0		2,051
1.7.8.3.1.5	Analog test facility	5,000	1,528	0		1,528
1.7.8.4.8	quality assurance	0	0	0		0
1.8.1.1.7.1.4	FY02 Documentation/Travelers	102,500	107,794	107,794		0
1.8.1.1.7.2.6	Finishing Integration in FY02	56,250	59,155	59,155		0
1.8.1.1.7.7	Finishing Integration of ME3/1, ME4/1, ME1/3	21,000	22,085	22,085		0
1.8.2.2.4	Production Engineer in FY02	180,000	189,297	189,297		0
1.8.2.4.2	Technical coordination related to primary assembly-FY00	137,600	34,626	34,626		0
1.8.3.1.1.4	FY02 Inspection	23,998	25,238	25,238		0
1.8.3.1.2.3	FY02 Kit Preparation	37,000	38,911	38,911		0
1.8.3.3.13.4	Epoxy in FY2002	19,300	20,297	20,297		0
1.8.3.3.14.4	Scotch Tape in FY2002	1,675	1,762	1,762		0
1.8.3.3.15.4	RTV in FY2002	10,700	11,253	11,253		0
1.8.4.1	Physicist in charge for production at Fermilab	0		0		0
1.8.4.2.1	Panel Production Supervision	0		0		0
1.8.4.2.5.4	Gerber and Axxiom MaintenanceFY02	10,040	10,559	10,559		0
1.8.4.2.6.4	Milling BitsFY02	7,560	7,950	7,950		0
1.8.4.2.9.5	Lab 8 manpower FY02	214,712	225,802	225,802		0
1.8.4.3.1.2	Chamber Assembly Supervision	476,320	139,743	139,743		0
1.8.4.3.2	Physicist at MP9 and Lab 7	0		0		0
1.8.4.3.8.8	Lead Tech	196,500	80,725	80,725		0
1.8.4.3.8.9	Six Assembly Techs	943,200	387,478	387,478		0
1.8.4.3.8.10.1	Visitor 1	75,000	32,261	32,261		0
1.8.4.3.8.10.2	Visitor 2	75,000	32,261	32,261		0
1.8.4.3.8.12	Overtime at MP9	42,066	27,049	27,049		0
1.8.4.3.12.1.4	Gas Expenses-FY02	4,160	4,375	4,375		0
1.8.4.3.12.2.3	Station Maintenance-FY02	10,080	10,601	10,601		0

1.8.4.3.12.3.4	48 ME23/2 chambers - crates	9,000	9,465	9,465		0
1.8.4.3.12.4.7	6th-9th 6-CSC racks are shipped to UF	8,000	8,413	8,413		0
1.8.4.3.12.4.8	6th-9th 6-CSC racks are shipped to UCLA	12,000	12,620	12,620		0
1.8.4.4.1	Physicist overseeing shipments to Foreign Sites	0		0		0
1.8.4.4.5.2	Shipping Panels+M&S to PNPI - 2002 (26 ME23/1)	11,000	11,568	11,568		0
1.8.4.4.5.4	PNPI Critical Tooling Maintenance	30,000	0	0		0
1.8.4.4.11.2	Shipping Panels+M&S to IHEP - 2002 (48 ME1/23)	12,900	13,566	13,566		0
1.8.4.4.11.4	IHEP Critical Tooling Maintenance	30,000	0	0		0
1.8.7.2.7	Equipment for chamber pre-tests at CERN	31,998	33,651	33,651		0
1.8.7.2.9	Storage/Pre-tests at CERN expenses-FY02	0	0	0		0
Total Cost			1,665,772	1,651,466	0	14,306

3.2. Coordination and Reporting

The US CMS Level 2 Manager for the Endcap Muon subsystem is Guenakh Mitselmakher. The institution contact person for Endcap Muon activities at Fermilab is Giorgio Apollinari for the CSC factory and David Eartly for the CSC alignment. The task managers for Endcap Muon activities carried out by the US CMS group at Fermilab are as follows:

Task	Task Manager
CSC Construction	G. Apollinari
Alignment System	D. Eartly
Integration Parts Shipment	O. Prokofiev

3.3. Procurement Authorization

Item purchases exceeding the delegated limit (currently $10k) must be authorized in advance of obligation by the US CMS Level 2 manager. Major procurements (currently $100k) must in addition have the written authorization of the US CMS Construction Project Manager. Items purchased as CMS Common Project items must be explicitly authorized by the US CMS Construction Project Manager and approved by the CMS Resource Manager, regardless of the cost.

3.4. Reporting to US CMS Project Management

The US CMS group at Fermilab will report all CMS related expenditures and labor charges together with associated technical progress in each item of work by Work Breakdown Structure (WBS) category (Level 7).

Technical progress will be reported by WBS element L4 to the Level 2 Manager and the TD/CPM on a quarterly basis and will cover all items covered in this Statement of Work regardless of the specific nature of the funding support.

The US CMS group at Fermilab agrees to furnish complete documentation of the quality control and performance checks which are carried out for US CMS in the performance of this work.

3.5. Collaboration with Other Groups and Institutions

Design, construction and installation related to the Endcap Muon subsystem will be carried out in close communication and collaboration with other groups working on this and related subsystems.

WBS / Task (L4)	Collab. Group	Responsibility with US CMS group at Fermilab

1.7.7	UWisc	Alignment system test parts
1.7.6, 1.7.7, 1.7.8	NEU	Alignment system design and tests
1.7.6, 1.7.7, 1.7.8	PNPI	Alignment system design and tests

4. Contribution of Effort, Services and Equipment

Subject to adequate funding by DOE or NSF, the US CMS group at Fermilab will provide support for the scientific and technical personnel as indicated in section 2 during this period of performance. This contribution refers only to support provided outside the US CMS Project.

5. Fermilab (as host institution) Effort, Services and Facilities

Tracking of Fermilab CMS support, whether provided by Fermilab or paid by the US CMS Project, will be done using appropriate effort reporting codes. The costs incurred will be reported to the Fermilab Director.

Contributing Fermilab personnel with the anticipated fraction of their time committed to CMS during this period of performance and their source(s) of support are:

5.1. Administrative Staff

Name	CMS Fraction	Source of Support

5.2. Engineers

Name	CMS Fraction	Source of Support

5.3. Designers

Name	CMS Fraction	Source of Support

5.4. Technical Specialists

Name	CMS Fraction	Source of Support

5.5. Programmers

Name	CMS Fraction	Source of Support

5.6. Others

Name	CMS Fraction	Source of Support

6. Costs and Funding

A total amount of $1,665,772 is detailed above for the full fiscal year. The MPO portion will be paid upon receipt and approval of invoices for the work by the Project Office at Fermilab. Management control requires the review and concurrence of the Level 2 Manager and the Project Office, as needed, for major expenditures, as defined above. The release of funds above the given thresholds will be contingent upon this concurrence.

7. Schedules and Milestones

The US CMS group at Fermilab will make every effort to carry out their institutional responsibilities consistent with the overall CMS schedule. In this Statement of Work are listed the program milestones for this period of performance.

The program milestones for this period of performance relevant to the US CMS group at Fermilab are listed here:

WBS	Program Milestones	Baseline Milestone Date	Current Milestone Date
1.8.1.1.23	Sign off ME1/3 Chamber Drawings		12/07/01
1.8.1.1.30	Sign-off Integration Drawings for ME2/1 Chambers		12/07/01
1.8.1.1.31	Sign-off Integration Drawings for ME3/1 Chambers		02/07/02
1.8.1.1.32	Sign-off Integration Drawings for ME1/3 Chambers		12/07/01
1.8.1.1.33	Sign-off Integration Drawings for ME4/1 Chambers		04/08/02
1.8.4.2.11	"+42=106 ME23/2, +20=40 ME23/1, +36=72 ME1/23 panels made"		10/01/01
1.8.4.2.14	38 ME4/1 panels delivered		06/03/02
1.8.4.3.9	+54=66 ME23/2 chambers assembled		01/31/02
1.8.4.3.10	+54=120 ME23/2 chambers assembled		09/30/02
1.10.1.1.2	52 ME23/2s assembled at Fermilab		10/30/01
1.10.1.1.3	57 ME23/2s assembled at Fermilab		11/30/01
1.10.1.1.4	61 ME23/2s assembled at Fermilab		12/31/01
1.10.1.1.5	66 ME23/2s assembled at Fermilab		01/31/02
1.10.1.1.6	72 ME23/2s assembled at Fermilab		02/28/02
1.10.1.1.7	78 ME23/2s assembled at Fermilab		03/31/02
1.10.1.1.8	84 ME23/2s assembled at Fermilab		04/30/02
1.10.1.1.9	90 ME23/2s assembled at Fermilab		05/31/02
1.10.1.1.10	96 ME23/2s assembled at Fermilab		06/30/02
1.10.1.1.11	102 ME23/2s assembled at Fermilab		07/31/02

1.10.1.1.12	108 ME23/2s assembled at Fermilab		08/31/02
1.10.1.1.13	114 ME23/2s assembled at Fermilab		09/30/02
1.10.1.2.2	21 Chambers shipped to UCLA FAST Site		12/17/01
1.10.1.2.3	26 Chambers shipped to UCLA FAST Site		12/17/01
1.10.1.2.4	31 Chambers shipped to UCLA FAST Site		03/15/02
1.10.1.2.5	36 Chambers shipped to UCLA FAST Site		03/15/02
1.10.1.2.6	41 Chambers shipped to UCLA FAST Site		06/17/02
1.10.1.2.7	46 Chambers shipped to UCLA FAST Site		06/17/02
1.10.1.2.8	51 Chambers shipped to UCLA FAST Site		09/16/02
1.10.1.2.9	56 Chambers shipped to UCLA FAST Site		09/16/02
1.10.1.3.1	21 Chambers shipped to UF FAST Site		12/17/01
1.10.1.3.2	26 Chambers shipped to UF FAST Site		12/17/01
1.10.1.3.3	31 Chambers shipped to UF FAST Site		03/15/02
1.10.1.3.4	36 Chambers shipped to UF FAST Site		03/15/02
1.10.1.3.5	41 Chambers shipped to UF FAST Site		06/17/02
1.10.1.3.6	46 Chambers shipped to UF FAST Site		06/17/02
1.10.1.3.7	51 Chambers shipped to UF FAST Site		09/16/02
1.10.1.3.8	56 Chambers shipped to UF FAST Site		09/16/02
1.10.2.2	38 ME3/1 CSC kits shipped to PNPI		01/31/02
1.10.2.3	38 ME4/1 CSC kits shipped to PNPI		04/30/02
1.10.3.1	74 ME1/2 CSC kits are shipped to IHEP		10/30/01
1.10.4.1.1	5 ME23/2 cooling plates are at UCLA		10/01/01
1.10.4.1.2	5 ME23/2 cooling plates are at UF		10/01/01
1.10.4.1.3	+5=10 ME23/2 cooling plates are at UCLA		12/15/01
1.10.4.1.4	+5=10 ME23/2 cooling plates are at UF		12/15/01
1.10.4.1.5	12 ME2/1 cooling plates at Fermilab ready to be shipped to PNPI		12/15/01
1.10.4.1.6	12 ME1/2 cooling plates at Fermilab ready to be shipped to IHEP		12/15/01
1.10.4.1.7	+5=15 ME23/2 cooling plates are at UCLA		02/15/02
1.10.4.1.8	+5=15 ME23/2 cooling plates are at UF		02/15/02
1.10.4.1.9	+12=24 ME2/1 cooling plates at Fermilab ready to be shipped to PNPI		02/28/02
1.10.4.1.10	+12=24 ME1/2 cooling plates at Fermilab ready to be shipped to IHEP		02/28/02
1.10.4.1.11	+10=25 ME23/2 cooling plates are at UCLA		03/31/02
1.10.4.1.12	+10=25 ME23/2 cooling plates are at UF		03/31/02
1.10.4.1.13	+14=38 ME2/1 cooling plates at Fermilab ready to be shipped to PNPI		05/15/02
1.10.4.1.14	+12=36 ME1/2 cooling plates at Fermilab ready to be shipped to IHEP		05/15/02
1.10.4.1.15	+10=35 ME23/2 cooling plates are at UCLA		06/15/02
1.10.4.1.16	+10=35 ME23/2 cooling plates are at UF		06/15/02
1.10.4.1.17	12 ME3/1 cooling plates at Fermilab ready to be shipped to PNPI		07/15/02
1.10.4.1.18	+12=48 ME1/2 cooling plates at Fermilab ready to be shipped to IHEP		07/15/02
1.10.4.1.19	+10=45 ME23/2 cooling plates are at UCLA		08/31/02
1.10.4.1.20	+10=45 ME23/2 cooling plates are at UF		08/31/02
1.10.4.1.21	+12=24 ME3/1 cooling plates at Fermilab ready to be shipped to PNPI		09/30/02
1.10.4.1.22	+12=60 ME1/2 cooling plates at Fermilab ready to be shipped to IHEP		09/30/02

15/04 '02 09:37 FAX +41 22 7677920 CERN EP/CMI → HERVE 003
04/12/02 10:57 FAX 630 840 2194 SDC FERMILAB 003
002
04/03/02 WED 17:10 FAX 352 392 8863 PHYSICS-HEE
10:30 FAX 630 840 2194 SDC FERMILAB 002

US CMS FY02 SOW vers 2.0

8. Makers and Concurrence

The following persons concur in the terms of this Statement of Work. These terms will be updated as appropriate in later Statements.

Makers of this Memorandum:

3/4/02
Dan Green (date)
US CMS Technical Director

03.04.02
David P. Eartly (date)
US CMS Group Principal Investigator
Fermilab

03/05/02
Guenakh Mitselmakher (date)
US CMS Level 2 Manager
Endcap Muon Subsystem

Concurrence:

4/10/02
Ken Stanfield (date)
Deputy Director
Fermilab

Copy sent to:

4/15/02
Alain Herve (date)
CMS Technical Coordinator

CMS Muon Integrated Cathode Strip Chambers

Configuration Change Control Specification

Integrated Chamber Type: ME 234/2
Serial Number Range: 001 +

Configuration: 1 **Release Date:**

Revision: None **Revision Date:**

(*)	Size	Dwg. No.	Rev.	Description
	ME-	400220	A	Integrated Chamber Main Assembly
	ME-	368220	I	Chamber Main Assembly
	MC-	400010	-	Anode Front End Electronics Board Assy
	MD-	400020	-	Cathode Front End Electronic Board
	MD-	400030	-	Low Voltage Distribution Board (LVDB)
	MD-	400031	-	LVDB Electronics Assy Kit
	ME-	400124	-	ALCT 384 Board Assembly
	ME-	400221	-	Anode Electronics Assy Kit
	ME-	400222	-	Cathode Electronics Assy Kit
	ME-	400223	-	ALCT Electronics Assy Kit
	ME-	400225	-	Cooling Plate Assy Kit
**	ME-	400226	-	Cable Kit
*	MX-	400228	-	Schematic, Integrated Chamber Assembly

(*) Change Description: * This drawing is not currently released or available at this time.

** Cable part numbers have been assigned for all cables but more information is needed before the cable kit drawing and Schematic can be finalized to show the beginning and end point of cable identified.

******** Approvals: ********

(primary/alternate)

Prepared by:

N. Chester

Approved by:

Gena Mitselmakher/Andrey Korytov — G.Mitselmakher ★

Andrey Korytov/Gena Mitselmakher — A Korytov ★

Richard Loveless/Farshid Feyzi — Richard Loveless ★

TY Ling/Tom Ferguson — T. Fergusen (by Email)

★.=by Email, Signature on File

February 25,1999
G. Apollinari

Failure Rate specifications for Chamber Components

Capacitor –Ceramic DHR15 Y5P 102M 7.5kV

Average lifetime not lower than 1.3 x 10^8 hours at 60% C.L. (or failure rate not larger than 0.0008%/1000 hours, corresponding to 8 FITS) .

Carbon Composition Resistors – 4.7 MΩ , 1 MΩ and 10 Ω

Average lifetime not lower than 1.2 x 10^7 hours at 60% C.L. for a change in resistance ($\Delta R/R$) of 10% (or failure rate not larger than 0.008%/1000 hours, corresponding to 80 FITS) .

Surface Mounted Resistors 10 Ω – Dale CRCW1206

Average lifetime not lower than 2 x 10^7 hours at 60% C.L. for a catastrophic failure (or a failure rate not larger than 0.005%/1000 hours, corresponding to 50 FITS) .

Motorola Switching Diode – BAV99LT1

Average lifetime not lower than 2 x 10^8 hours at 60% C.L. (or failure rate not larger than 0.0005%/1000 hours, corresponding to 5 FITS) .

Surface Mounted Capacitor – Murata GRM42-6Z5U 0.1 uF

Average lifetime not lower than 1.7 x 10^8 hours at 60% C.L. (or failure rate not larger than 0.0006%/1000 hours, corresponding to 6 FITS) .

CMS-EMU FNAL Factory
Division of Responsibilities

November 30th, 1999

This **CMS-EMU FNAL Factory Division of Responsibilities** covers the assignment of tasks and responsibilities for personnel operating the manufacturing and testing sites of the CMS-EMU Factory at Fermilab. As such, this is a working document, which may require modification as the need for new resources and/or new tasks are identified.

Fermilab will assemble approximately 148 chambers and will provide kits for additional 224 smaller chambers to be assembled at PNPI (Russia) and IHEP (China). Personnel required for tooling development, product development, quality assurance, and floor management will be provided jointly by PPD, TD and the CMS Muon Project.

1. FNAL Site Management

1.1. Site Manager

1.1.1. The Site Manager (Giorgio Apollinari) will have full management responsibility for the procurements of parts and fabrication of the chambers and chamber kits.

1.1.2. The Site Manager, upon consultation with the Project Engineer, will have primary control over the activation or deactivation of the factory line.

1.1.3. The Site Manager will be responsible for the CMS Endcap Muon Chambers performance in accordance with the CMS-EMU Technical Specifications and any modification/addition provided by the CMS-EMU L2 and L3 Managers (Gena Mitselmaker and Andrey Korytov respectively).

1.1.4. The Site Manager will report on the FNAL part of the Project Cost and Schedule. He will report to the appropriate L2 and L3 CMS Muon Project Managers and to the US CMS Management Office according to the format established by the appropriate level of Management.

1.1.5. The Site Manager will approve procurements for the CMS-EMU factory in agreement with the CMS project Cost Estimate. In agreement with the appropriate L2-L3 managers, he will provide general guidelines for the finalization of R&D tasks and the transition to production.

1.1.6. The Site Manager will act in agreement with the approved Resource Loaded Schedule in the definition of the FNAL factory tasks.

1.2. Project Engineer

1.2.1. The Project Engineer (Nelson Chester) has control over all the engineering aspects of the factory. These aspects include tooling design, chamber drawings, assembly procedures and technical specifications.

1.2.2. The Project Engineer has full responsibilities for the sign-off of Discrepancy Reports (DR) and the initiation of Engineering Change Requests (ECR). He can delegate the DRs sign-off to the Production Floor if he elect to do so. He will seek advice from the project Technological Physicists (Oleg Prokofiev and Yuri Pishialnikov) when needed.

1.2.3. The Project Engineer will review the setup of chamber assembly at FNAL and at the remote sites (FAST Sites at University of Florida and University of California at Los Angeles) providing guidance where needed.

1.3. Foreign Sites Coordination

1.3.1. The Foreign Site Coordinator (Victor Yarba) will work in consultation with the Site Manager and will have control and responsibility for the coordination of activities with the foreign assembly sites (PNPI, Russia and IHEP, China).

1.3.2. The Foreign Site Coordinator will be responsible for gathering the proper information from the Foreign Assembly Sites representatives to help and expedite the custom clearance of FNAL shipments through the foreign custom offices.

2. Engineering

2.1. General Aspects

2.1.1. The engineering group is headed by the Project Engineer. The Project Engineer has full control and responsibility for the engineering group, which includes the chamber and tooling engineers (Vladislav Razmyslovitch and Evgeni Borissov respectively), any draftsperson needed for drawings finalization and any engineer visiting from the foreign assembly sites.

2.1.2. The Project Engineer will have responsibility for the production of all the chamber and tooling drawings, their checkout, the drawing release and the purchase release to maintain production according to the CMS-EMU schedule.

2.1.3. The Project Engineer will be responsible for the integration of other institution drawings (Wisconsin) in the TD-FNAL system and the checkout of those drawings for appropriate use on the production floor.

2.1.4. The Project Engineer will act as advisor for production activities at FAST Site and at the foreign assembly sites.

2.1.5. Prompted by the US CMS Managers and/or the appropriate L2-L3 managers, the Project Engineer will edit, update, and seek required approvals for release of all technical specifications and engineering drawings.

2.1.6. The Project Engineer will initially release and maintain all the released specifications and technical drawings, entering them in the TD Document Control System (DCS) and in the CERN Drawings Database. All released drawings and specifications will be assigned Fermilab part numbers.

2.1.7. The Project Engineer will be responsible for distributing released drawings and specifications and documenting all the engineering changes and the disposition of non-conforming materials during the course of production.

2.2. Drawings Preparation

2.2.1. The Chamber Engineer (Vladislav Razmyslovitch) will be responsible for providing, releasing after approval, and controlling through the appropriate TD procedures, all sets of the final chamber drawings prior to the Design Review and the beginning of production (ME234/2) or prior to parts shipments to the foreign sites.

2.2.2. The Tooling Engineer (Evgeni Borissov) will be responsible for providing, releasing after approval, and controlling through the appropriate TD procedures, all sets of the final tooling drawings prior to the beginning of production or shipment to the foreign sites.

2.2.3. The Project Engineer is responsible for acknowledging the need and requesting from the Site Manager appropriate resources for the documentation of the electrical and electronic circuit of the production tooling.

2.3. Drawings Sign-off

2.3.1. The Project Engineer only will be responsible for the drawings sign-off. When convenient, he may delegate the actual signing process to the Site Manager or another person of his choice.

2.4. Purchase Releases

2.4.1. The Project Engineer or the Site Manager will generate the purchase releases for the procurement of production parts according to the CMS-EMU schedule.

2.4.2. To insure procurement to the proper drawing or technical specifications, all purchase releases will be submitted or verbally approved by the Project Engineer.

2.5. Technical Specifications

2.5.1. Technological Physicists and Production Floor Managers will be responsible for communicating to the Project Engineer the proper technical specifications for parts and tooling needed for the chamber assembly.

2.5.2. The Project Engineer will be responsible for editing and maintaining the project technical specifications, assigning them appropriate document control numbers.

3. Procurement & Inspection

3.1. Parts Procurement

3.1.1. The Procurement & Inspection Group (Gregg Kobliska) will be responsible for the procurement of parts for the CMS-EMU project. Procurement will take place from vendors or Universities, based on directions from the Site Manager and Project Engineer.

3.1.2. The Procurement Group will act on Purchase Releases generated by the Site Manager/Project Engineer and processed through the Process Engineer Group (Bob Jensen) by T.J. Gardner. The Procurement Group will work on drawings released and stored in the TD DCS System and generate Purchase Requests in the most expeditious way.

3.1.3. In very exceptional circumstances, when a procurement is urgent and the released process may not be fast enough to provide the Procurement Group with the latest version of a drawing, the Project Engineer is responsible for providing a copy of the latest version of a released drawing for Procurement.

3.2. Parts Inspection

3.2.1. All the parts will undergo inspection with a sampling determined by experience and agreed upon between the Inspection Group and the Site Manager/Project Engineer.

3.2.2. The Project Engineer will be responsible for providing the Inspection Group with documentation indicating the critical dimensions to inspect in any part of the CSC Chambers.

3.2.3. Non-discrepant parts will be documented following the standard TD practice. The Inspection group will be responsible for stocking and documenting the parts appropriate for production and for replacement of the discrepant parts, according to directions from the management.

3.2.4. The Inspection group will be responsible for pointing out inadequacies-mistakes in the drawings. The Project Engineer will be responsible for the drawing correction and re-release.

4. Kits Preparation and Shipping

4.1. Chamber Kits for FNAL

4.1.1. Kits for the chambers to be assembled at Fermilab will be prepared and staged by the Pro-Eng group. T.J. Gardner will have responsibility for obtaining the appropriate Engineering Releases and Engineering Change Orders when applicable, and prepare kits to be staged before shipment to MP9 for chamber assembly. Chamber panels will not be part of these kits and will be delivered directly to the MP9 Floor Manager (G.Smith) from the Procurement and Inspection Group.

4.1.2. When necessary, the MP9 Inventory Control Expert (Lamar Lee) will have responsibility for releasing in a timely manner Additional Parts to the production floor. When the necessity of an Additional Part Release arises from a drawing inaccuracy, the MP9 Inventory Control Expert will have the responsibility of notifying the Site Manager/Project Engineer. Additional Parts requests can be process directly by the MP9 Inventory Control Expert without the Site Manager/Project Engineer approval, to expedite the delivery of parts on the production floor. The MP9 Inventory Control Expert will have responsibility for recording and documenting the parts delivered to the Production floor through Additional Part Requests.

4.1.3. The Site Manager will communicate the schedule for Kits preparation after consultation with the MP9 Floor Manager during the pre-production stage (FY 2000). During production, the MP9 Floor Manager will schedule the delivery of kits to MP9 according to the production needs.

4.1.4. Transportation of kits to/from the various assembly sites will be a responsibility of the Procurement and Inspection group.

4.2. Chamber Kits for China-Russia

4.2.1. Kits for chambers to be assembled in China (IHEP) and Russia (PNPI) will be prepared by the Pro-Eng group. T.J. Gardner will have responsibility for obtaining the appropriate Engineering Releases and Engineering Change Orders when applicable, and prepare kits to be shipped to IHEP or PNPI. Chamber panels will be part of these kits.

4.2.2. When necessary, request for additional parts from the foreign sites will be transmitted to the Procurement and Inspection group. After approval from the Site Manager/Project Engineer, T.J. Gardner will have responsibility for releasing on a timely manner Additional Parts to Russia and China.

4.2.3. The Site Manager will communicate the schedule for Kits preparation after consultation with the L2-L3 Managers.

4.2.4. Transportation and shipment of kits will be the responsibility of the Procurement and Inspection group.

4.2.5. Design of the containers for the kit shipment will be a responsibility of the Engineering group. Kits will be prepared in a location agreed upon by the Pro-Eng group and the Procurement and Inspection group.

5. Production Tooling

5.1. FNAL Tooling

5.1.1. Responsibilities for chamber production tooling in MP9 is assigned according to the document "PPD-TD Agreement". In general, mechanical responsibility lies with the TD group, while responsibility for the electrical and electronics support lies with PPD.

5.1.2. The Site Manager and/or Project Engineer may delegate maintenance responsibilities for the Fermilab tooling to the proper experts.

5.2. PNPI/IHEP Tooling

5.2.1. Critical tooling for IHEP and PNPI will be assembled, commissioned and debugged in MP9. The Site Manager/Project Engineer will assign responsibility for the tooling preparation in accordance to individual capabilities and resources availability.

5.2.2. The MP9 Floor Manager (Glenn Smith) has responsibility to provide floor space and, if needed, manpower for the mechanical assembly of the critical tooling.

5.2.3. The CMS Project Electrical Support Technician (Curtis Danner) will have responsibility for the installation and commissioning of the electrical components of the Tooling.

5.2.4. The MP9 Technological Physicist (O. Prokofiev) will have responsibility for the tooling commissioning and testing. The MP9 Technological Physicists, in conjunction with the Foreign Site Coordinator and the Tooling Engineer, will have responsibility for the preparation of documentation for shipment to the foreign sites.

6. Interfacilities Transfers

6.1. Transfers to/from Lab 8

6.1.1. Lab 8 is the facility where panels are cut, drilled and machined for further needs of the factory. Lab 8 will machine all the panels of the EMU project, including the panels destined to China (IHEP) and Russia (PNPI).

6.1.2. The Procurement and Inspection group will have responsibility for transfering raw panels to Lab 8 and machined panels from Lab 8 into the designated storage area.

6.1.3. The Lab 8 Floor Manager (P. Deering) will have responsibility for requesting transfer of panels to the Procurement and Inspection group.

6.1.4. The Lab 8 Floor Manager will have responsibility to request raw panels to maintain the highest production rate with no delay or slowdown due to non-machine related problems, like lack of access to the building or floor plan modifications. The Lab 8 Floor Manager will also have responsibility for allocating floor space for the needs of the CMS-EMU factory.

6.2. Transfers to/from MP9

6.2.1. MP9 is the facility where all kits and panels will converge for the CMS-EMU chamber assembly.

6.2.2. The Procurement and Inspection group will have responsibility to deliver to MP9 kits for chamber assembly (panels excluded) upon communication from the kits originator (T.J.Gardner) and the MP9 Floor Manager (Glenn Smith).

6.2.3. The procurement and Inspection group will be responsible for delivering to the MP9 Floor Manager panels for cleaning and further assembly in the designated cleaning area. The subsequent transfer of panels to the MP9 factory, if necessary, will be a responsibility of the MP9 floor Manager.

6.2.4. After completion and certification, chambers will be stored in shipping containers. The Procurement and Inspection group will be responsible for shipment to the FAST sites upon communication from the MP9 Floor Manager. If immediate shipment is not possible, the Procurement and Inspection group will be responsible for storing and tracking the chambers in a designated storage area.

6.3. Transfer to/from Lab 7

6.3.1. Lab 7 is the facility where chambers can be tested using a Cosmic Ray setup. The expectation is that Lab 7 will receive only the prototypes produced at MP9 (~5 chambers) and no more than 5-10% of the chambers produced by the factory (~10 chambers) for purposes of QC. All the other chambers will be shipped to the FAST sites without a cosmic ray test at Lab 7.

6.3.2. The Procurement and Inspection group will be responsible for delivering chambers from MP9 to Lab 7 upon communication from the Site Manager and the MP9 Floor Manager. The same group will have responsibility to place the chamber on the cosmic ray stand following standard safety practices.

6.3.3. When a chamber needs to be shipped from Lab 7, the Procurement and Inspection group will be responsible for removing the chamber from the cosmic ray stand, load it in the shipping container and move it to "Shipping and Receiving".

6.3.4. The designation of containers for shipment will be a responsibility of the Engineering group.

7. Lab 8 Production

7.1. Production Travelers

7.1.1. Travelers Drafting

The Technological Physicist in Lab 8 (Y.Pischalnikov) will be responsible for drafting travelers in Lab 8. The Technological Physicist will also be responsible for proposals to modify and draft travelers for panels whenever new procedures, improvements or better instructions need to be included in the manufacturing process.

7.1.2. Travelers Revision

The Pro-Eng group and the Lab 8 Floor Manager will revise the Lab 8 procedures and engineer them for the production process.

7.1.3. Travelers Sign-off

The Site Manager and Project Engineer will sign-off the travelers. The Pro-Eng group will manage travelers.

7.1.4. The Pro-Eng group will control and manage the travelers. The Pro-Eng group will be responsible for updating the travelers when changes become necessary with inputs from the Technological Physicist or the FNAL Site Management.

7.1.5. The Pro-Eng group will be responsible for the collection of travelers from different production sites (Lab 8, MP9, and Lab 7) and their consolidation in a chamber book. The Pro-Eng group will also be responsible for scanning the travelers and storing them in electronic format.

7.1.6. The Pro-Eng group will be responsible for collecting the QA/QC measurements and panels parameters from the Lab 8 production.

7.2. Parts Control

7.2.1. Incoming/Outgoing Panels

7.2.1.1. The Site Manager will be responsible for specifying the panels production schedule in agreement with the overall CMS-EMU project schedule and FNAL responsibilities for panels delivering to the foreign assembly sites.

7.2.1.2. The Lab 8 Floor Manager will be responsible for notifying the TD Procurement group about the necessity of transferring to Lab 8 raw panels for machining. TD Procurement group will act on a simple notification from Lab 8 Floor Manager.

7.2.1.3. The Lab 8 Floor Manager will be responsible for allocation of floor space for incoming and outgoing panel boxes.

7.3. Documentation, Training and Tooling Maintenance

7.3.1. Drawings

7.3.1.1. The TD Pro-Eng group will be responsible for transferring to Lab 8 released drawings of panels for manufacturing.

7.3.1.2. The Lab 8 Floor Manager will be responsible for proper storage and handling of the released drawings.

7.3.2. Tools Operation

7.3.2.1. The Lab 8 Floor Manager will be responsible for proper maintenance, operating instructions and personnel training of the machining tools (Gerber and Axxiom machines) in Lab 8. In particular the Floor Manager will institute proper maintenance contracts (or other maintenance procedure agreed upon by the FNAL Site Management), financed by PPD, with outside contractors to insure continued operations of the Gerber and Axxiom machines. The Floor Manager will be responsible for training PPD personnel on the usage and operation of the machines and for writing proper instructions and procedures. The Lab 8 Floor Manager will also be responsible for the simple tooling used for panel deburring and holes chamfering.

7.3.2.2. The TD Engineering group will be responsible for proper maintenance, operating instructions and personnel training of the strip position measuring devices. The Lab 8 Technological Physicist will be responsible for training PPD personnel on the usage and operation of the machines and for writing proper instructions and procedures.

7.4. Production Tasks and Production Flow

7.4.1. The Lab 8 Floor Manager will be responsible for monitoring production and report to the Site Manager on a weekly basis the status of activities in Lab 8 and the progress on panel production. Weekly meeting and e-mail messages are adequate for this information transfer.

7.4.2. The Lab 8 Technological Physicist will represent the FNAL Site Management in the study of possible improvements of the production flow and/or the modification of production tasks to achieve the specifications listed in the assembly drawings. The Lab 8 Technological Physicist will also be responsible for the initial monitoring of the production quality, and for the analysis, during production, of the quality level and the CMS-EMU database entries.

7.4.3. The Lab 8 Site Manager will have sole authority to direct the Factory work force in the various aspects of panel production which includes panels cutting on the Axxiom and Gerber machines and panels deburring.

7.5. Quality Control and Quality Assessment

7.5.1. The Lab 8 Floor Manager will be responsible for the training of technicians in following the travelers and quality control procedures prepared by the Pro-Eng group.

7.5.2. The Pro-Eng group will be responsible for Quality Auditing on a regular basis to be defined by consultation between the Technological Physicist and the FNAL Site Management.

7.5.3. The Pro-Eng group will be responsible for the collection of Lab 8 travelers and the fill-up of the CMS-EMU database with the appropriate information.

7.5.4. The FNAL Site Manager will be responsible for transmitting to the Pro-Eng group the appropriate information to be saved on the CMS-EMU Database.

7.5.5. The Lab 8 Floor Manager will be responsible for communicating to the Pro-Eng group the presence of discrepancies. The Pro-Eng group will be responsible for the documentation of the discrepancies. The implementation of action items determined by discrepancies will be a responsibility of the Lab 8 Floor Manager.

8. MP9 Production

8.1. Production Travelers

8.1.1. Travelers Drafting

The Technological Physicist in MP9 will be responsible for the drafting of travelers in MP9. The Technological Physicist will also be responsible for proposals to the modification and drafting of travelers for new panels whenever new procedures, improvements or better instructions need to be included in the manufacturing process.

8.1.2. Travelers Revision

The Pro-Eng group and the MP9 Floor Manager (G.Smith) will revise the MP9 travelers, verify their accuracy versus the released drawings and engineer them for production.

8.1.3. Travelers Sign-off

The Site Manager and Project Engineer will sign-off the travelers.

8.1.4. The Pro-Eng group will control and manage the travelers. The Pro-Eng group will be responsible for updating the travelers when changes become necessary with inputs from the Technological Physicist or the FNAL Site Management.

8.1.5. The Pro-Eng group will be responsible for collection of travelers from different production sites (Lab 8, MP9, and Lab 7) and their consolidation in a chamber book. The Pro-Eng group will also be responsible for scanning the travelers and storing them in electronic format.

8.1.6. The Pro-Eng group will be responsible for the database collecting parameters from the MP9 Chamber Production.

8.2. Tooling Procedures

8.2.1. The FNAL Site Management will assign the drafting Tooling Procedures to the most appropriate tooling expert. These assignments will take place through verbal communication, e-mail or during a weekly meeting.

8.2.2. The MP9 Technological Physicist will be responsible for the documentation of new proposal or changes in the tooling procedures. The FNAL Site Management will evaluate the new proposals. If approved, they will be documented and transmitted to the MP9 Floor Manager.

8.2.3. The MP9 Technological Physicist will be responsible for the maintenance of the gas system in MP9.

8.2.4. Revision and engineering of the tooling procedures will be a responsibility of the Pro-Eng group. The Pro-Eng group will also be responsible for engineering and drafting the procedures for tools used at the foreign assembly sites (PNPI, Russia and IHEP, China).

8.3. Parts Control

8.3.1. The FNAL Site Management will be responsible for specifying the chamber production schedule in agreement with the overall CMS-EMU project schedule. Parts will be delivered to MP9 in panels and kits.

8.3.2. Incoming Panels

8.3.2.1. Panels for FNAL production will be released to the MP9 Floor Manager prior to their cleaning. It will be a responsibility of the MP9 Manager to arrange panel transportation to MP9.

8.3.2.2. Panels for Foreign sites production will not be released by the Procurement group. MP9 will provide the manpower to clean the panels, but the Procurement group will keep responsibility for their tracking and subsequent shipment to the foreign sites.

8.3.3. Kits for FNAL Production

8.3.3.1. The MP9 Inventory Control Expert will be responsible for Kits control and Additional Parts Request whenever a kit is short in some components.

8.3.3.2. The MP9 Floor Manager will be responsible for allocation of floor space for incoming and outgoing kit boxes.

8.3.4. Outgoing Chambers

8.3.4.1. The MP9 Floor Manager will store boxes of completed chambers in the MP9 area (or other agreed location) until a box is ready for shipment to the US FAST Sites (University of Florida or UCLA). At that time, the MP9 Floor Manager will be responsible for notifying the TD Procurement group about the necessity of initiating the shipment.

8.4. Manpower Training

8.4.1. The MP9 Floor Manager will have responsibility to train the MP9 work force in reading the drawings and implementing the drawings indications.

8.4.2. The MP9 Floor Manager will have responsibility for training of the MP9 work force in the usage of the factory tools. The MP9 Floor Manager can access, at its discretion, the MP9 Technological Physicists or other Physicists in the project to provide guidance to the factory work force.

8.4.3. The MP9 Technological Physicist will have responsibility for training the factory work force in the usage of the equipment for the various open air HV tests.

8.5. Production Tasks

8.5.1. The MP9 Floor Manager will be responsible for monitoring production and report to the FNAL Site Management on a weekly basis the status of activities in MP9 and the progress on Chamber production. Weekly meeting and e-mail messages are adequate for this information transfer.

8.5.2. The MP9 Technological Physicist will represent the FNAL Site Management in the study of possible improvements of the production flow and/or the modification of production tasks to achieve the specifications listed in the Assembly Drawings. The production physicist will also be responsible for the initial monitoring of the production quality, and for the analysis, during production, of the quality level and the CMS-EMU database entries.

8.5.3. The MP9 Floor Manager will have sole authority to direct the Factory work force in the various aspects of chamber production which includes panel gluing, winding, soldering (both automatic and discrete components soldering), panel HV test in air, chamber assembly, sealing and leak testing.

8.5.4. The Purdue University group will have responsibility for Tension testing, wire position measurements and Capacitance measurements on all the panels going through production in MP9.

8.5.5. The MP9 Production Physicist will have responsibility for the HV training of a completed chamber.

8.6. Quality Control and Quality Assessment

8.6.1. The MP9 Floor Manager will be responsible for the training of technicians in following the travelers and quality control procedures prepared by the Pro-Eng group.

8.6.2. The Inventory Control Expert will be responsible for Quality Auditing on a regular basis to be defined by consultation between the Technological Physicist and the FNAL Site Management.

8.6.3. The Pro-Eng group will be responsible for the collection of MP9 travelers and the fill-up of the CMS-EMU database with the appropriate information.

8.6.4. The FNAL Site Management will be responsible for transmitting to the Pro-Eng group the appropriate information to be saved on the CMS-EMU Database.

8.6.5. The MP9 Floor Manager will be responsible for communicating to the Pro-Eng group the presence of discrepancies. The Pro-Eng group will be responsible for the documentation of the discrepancies. The implementation of action items determined by discrepancies will be a responsibility of the MP9 Floor Manager.

8.6.6. Resolution of the MP9 discrepancies will be the sole responsibility of the FNAL Site Manager or the Project Engineer.

Prepared by:

G. Apollinari

Reviewed by:

D.Green (US-CMS L1) ________________
G.Mitselmakher (US-EMU L2) ________________
A.Korytov (US-EMU L3) ________________
M.Crisler (PPD Engineering Centers Head) ________________
V.Yarba (TD Engineering Group Head) ________________
G.Kobliska (TD Procurement Group Head) ________________

Approved by:

K.Stanfield ________________
J.Cooper ________________
P.Limon ________________

Fermi National Accelerator Laboratory

Batavia, IL 60510

TEST & INSPECTION SPECIFICATIONS 5520-ES-368037

for CMS Endcap Muon Cathode Strip Chambers

Prepared by: N. Chester

Approved by:

Andrey Korytov
Giorgio Apollinari
Nelson Chester
Oleg Prokofiev

Revision	**Date**	**Description**	**Approval(s)**
0	**4/1/02**	**Initial Engineering Release ER # 7280**	**See Above**

The Specifications provided herein are the Test and Inspection requirements to which each Cathode Strip Chamber manufactured must conform . The manufacturing traveller for each chamber will define the frequency and details of how the tests and inspections are to be carried out to verify these specifications.

1.0 PANEL VENDOR

1.1 The vendor is to supply certificates of material compliance on each lot of parts. Sample parts are to be measured during the production run to ensure proper dimensions and tolerances. The measurements are to be written/documented on a data sheet. A copy of the measurement data for each run is to be mailed to Fermilab Technical Division Materials Control Group when the material is shipped. The sampling plan for measuring panels is to be mutually agreed upon between the vendor and Fermilab.

1.2 Parts having copper surface imperfections or any other defects are to be rejected at the vendor. Fermilab reserves the right to visit the vendor and inspect the parts prior to shipment. FNAL reserves the right to make final assessment of the shipped parts following receipt of the parts and after a sampling of parts have been routed through Receiving Inspection.

2.0 PANELS AFTER LAB 8 MACHINING, CLEANING, DEBURRING

2.1 The panel surfaces must be free of dirt, oxide, oils, (no fingerprints or the like) and other particulate from the machining process. Edges of machined tracks must be free of copper burrs, particulate, and glass whiskers.

2.2 The cathode strip to strip and strip to ground resistance must be **equal or greater than 50 MΩ.**

2.3 The depth of cut from Gerber machine to be **0.006" +/- 0.002" (0.152 +/- 0.051 mm)** and the **width of a single cut** to be **0.025" +/- 0.005" (0.635 +/- 0.127 mm) in "X" direction and 0.037"+/ - 0.017" (0.940 +/- 0.432 mm) in "Y" direction.**

2.4 Strip position relative to the alignment hole position must be measured and documented. Alignment marks per the engineering drawings are to be incorporated into the Gerber machining process at both ends of the panels to indicate the location of several strip positions. Strip position marks near the ends and center of the panel are required on both the wide and narrow ends. The distance between the alignment marks and the center of the alignment pin holes are to be recorded in the appropriate travelers.

3.0 GLUED PANELS

3.1 Height of glued Cathode Panel Gap Bar to Panel Surface to be **0.375" +/-0.005" (9.525 +/- 0.127 mm).**

3.2 Height of glued Anode Panel Wire Fixation Bar to Panel Surface to be **0.188" +/-0.005" (4.775 +/- 0.127 mm).**

3.3 Spaces between gap bars must be filled with epoxy.

4.0 WOUND AND SOLDERED WIRE ANODE PANELS

4.1 When the **200** micron wires are set in place on an Anode Panel the Winding Combs must be adjusted so that all of these wires are **equally centered to the extent possible**. **No wire may to be less than 0.010" from the edge of the wire fixation bar pad.**

The tension for **200** micron wires must generally be **500 grams +/- 50 grams. Tensions outside of this range can be accepted according to the following table**:

Location	**Allowable 200µ Wire Tension Range (grams)**		
	ME1/2 - ME1/3	**ME2/1 - ME4/1**	**ME234/2**
Narrow End	**200 - 800**	**200 - 800**	**200 - 800**
1st button	**350 - 800**	**350 - 800**	**300 - 800**
2nd button	**400 - 800**	**400 - 800**	**350 - 800**
3rd button	**N/A**	**N/A**	**400 - 800**
4th button	**N/A**	**N/A**	**450 - 800**
Wide End	**450 - 800**	**450 - 800**	**450 - 800**

4.2 During Wire Winding, the 50 µ wire should be **centered on the Wire Fixation Bars to the extent possible** based on the setup activity of 4.1. . **No wire may to be less than 0.010" from the edge of the wire fixation bar pad.**

4.3 The tension in the **50 µ** wires must generally be **260 grams +/-26 grams**. **Tensions outside of this range can be accepted according to the following table:**

Location	**Allowable 50 µ WireTension Range (grams)**		
	ME1/2 - ME1/3	**ME2/1 – ME4/1**	**ME234/2**
HV SEGMENT 1 (NE)	**200 – 300**	**200 – 300**	**200 – 300**
HV SEGMENT 2	**200 – 300**	**234 – 300**	**200 – 300**
HV SEGMENT 3	**234 – 300**	**234 – 300**	**200 – 300**
HV SEGMENT 4	**N/A**	**N/A**	**234 – 300**
HV SEGMENT 5 (WE)	**N/A**	**N/A**	**234 – 300**

4.4 Wires cut from behind Wire Fixation Bar Solder Pads must be cut flush with solder pad to the extent possible. **Not more than 0.010" (0.254 mm) of wire** may extend out beyond the solder pad.

4.5 The Allowable Spacing between Anode Panel Wires Centers:

Between 50 µ - 50 µ Wires = Nominal* +/- 0.014" (+/- 0.35 mm)
Between 50 µ - 200 µ Wires = Nominal* +/- 0.024" (+/- 0.60 mm)
***Nominal is 0.1245" (3.16 mm) for 10^{O} Chambers and 0.1228" (3.12 mm) for 20^{O} Chambers.**
The total accumulated error in wire spacing across all of the wires may **not be larger than 0.070" (1.778 mm).**

4.6 Strip to Strip and Strip to Ground Resistance to be **50 MΩ Minimum.**

5.0 HAND SOLDERED PANELS

5.1 Strip to Ground Resistance to be **1.0 MΩ +/- 0.10 MΩ.**

5.2 Capacitance between Wire Group to Ground as measured through each channel of every Anode Protection Board to be **roughly between 100 pf and 200 pF. A zero value or value that is approximately twice the value of an adjacent channel is indicative of a short in the connections of adjacent wire groups.**

5.3 Allowable leakage current in open air between Anode Panel Wires and Ground while wires are at **4.5** kV Potential to be **less than 0.1 µA per individual wire segment.**

5.5 Lemo Connector to Ground Resistance to be **51 Ω +/-5Ω.**

6.0 DRY ASSEMBLED CHAMBER

6.1 With chamber wires exposed to air, the allowable leakage current between Anode Panel Wires and Ground while wires are at **3.8** kV Potential to be **5.0 µA maximum per chamber segment.**

6.2 Capacitance between Wire Group to Ground as measured through each channel of every Anode Protection Board to be **roughly between 100 pf and 200 pF. A zero value or value that is approximately twice the value of an adjacent channel is indicative of a short in the connections of adjacent wire groups.**

7.0 SEALED ASSEMBLED CHAMBER FINAL ACCEPTANCE TESTS

7.1 The chamber Internal Air Leak Rate pressurized to 3.0" (7.5 mbar) of H_2O may not exceed **2.0 cm^3/m for ME 234/2 and 1.0 cm^3/m for all others.**

7.2 The Capacitance of any Wire Segment to Ground to be **roughly between 100 pf and 200 pF. A zero value or value that is approximately twice the value of an adjacent channel is indicative of a short in the connections of adjacent wire groups.**

7.3 With the white High Voltage Panel Leads disconnected from the High Voltage Wire Harness Glastic Channel Connector Sockets, and with 4.0 Kilovolts applied to all of the appropriate pins of the Chamber Redel High Voltage Connector, the Leakage Current through the High Voltage Harness after no more than 10 minutes must be **no more than 0.03 µA.**

7.4 The Resistance across Interlock Pins of High Voltage Harness to be **no more than 5.0 Ω in Closed Position and a Minimum of 1.0 MΩ in Open Position.**

7.5 With 30 VDC applied to voltage inputs at High Voltage Connector, **the same voltage must appear on each Chamber High Voltage Segments with the High Voltage banana plugs reconnected to the Glastic Channel Sockets.**

7.6 High Voltage Leakage Current Test and Training is to start after a 48 Hr. Gas Purge of 10% CF_4, 40% Ar, and 50% CO_2 at a purge rate of 0.4 l/min for ME 234/2 and 0.2 l/min for all others. This is to allow a minimum of 5 to 6 times the chamber volume of gas to be exchanged before Test and Training is started. After completing the chamber gas purge the High Voltage Leakage Current Test and Training is to be started. The chamber Wire Voltage is to be raised slowly from **3.3** kV to **4.0** kV, with the peak Leakage Current noted.

7.7 Under Chamber Reverse Voltage Training at **3.3** kV, the Leakage Current is to be no higher than **30.0 μA Maximum per Chamber** after no more than 1.0 hour of dwell time.

7.8 Upon completion of the High Voltage Training, the Leakage Current, with **4.0** kV applied to the Chamber High Voltage System is to be **no more than 0.1 μA continuous per plane anytime during a 24 hour hold period, and must not trip with the specified Sensing Instrument high current threshold set at 10.0 μA.** Oscilloscope traces (with scope set to 5 mv/div and 0.5-1.0 msec/div) of each wire group or anode channel must be observed through each Anode Protection Board with the 4.0kV applied. **The fundamental signal must exist at each anode channel with NO Corona signal observed.**

7.9 Prior to Packaging each Chamber, the **Frame Assembly Bolt Torques settings are to be checked and verified that they are between 50-60 in-lbs.**

CMS ME234/2 Travelers (Fermi)

LAB #8 PANEL

Traveler Name	Traveler No. #	Pages	Status	Completion Date
Axxiom Panel Cutting				
Anode	5520-TR-333355	8	Revision E	7/27/00
Cathode				
Upper	5520-TR-333356	9	Revision E	7/27/00
Inner	5520-TR-333251	9	Revision A	7/27/00
Lower	5520-TR-333252	9	Revision A	7/27/00
Gerber Panel Routing				
Anode	5520-TR-333357	17	Revision D	7/31/00
Measurement Form	*5520-FM-333392*	2	*Revision A*	*11/5/99*
Cathode				
Upper Panel	5520-TR-333359	14	Revision C	10/27/99
Measurement Form	*5520-FM-333393*	2	*Revision A*	*11/5/99*
Inner Panel	5520-TR-333360	13	Revision C	7/31/00
Measurment Form	*5520-FM-333394*	2	*Revision A*	*11/5//99*

MP-9 - PANELS

Traveler Name	Traveler No. #	Pages	Status	Completion Date
Panel Cleaning/Preparation (AWH)			Excel Spreadsheet	
Panel Preparation/Glueing				
Anode Panels	5520-TR-333361	17	Revision D	10/24/01
Measurement Form	*5520-FM-333473*	*2*	*Revision A*	*7/25/00*
Cathode Panels				
Upper Panel	5520-TR-333362	11	Revision D	10/24/01
Measurement Form	*5520-FM-333474*	*2*	*Revision A*	*7/25/00*
Inner Panel	5520-TR-333363	19	Revision D	10/24/01
Measurement Form	*5520-FM-333475*	*2*	*Revision A*	*7/25/00*
Lower Panel	5520-TR-333364	9	Revision D	10/24/01
Panel Wire Winding				
Anode Panels	5520-TR-333365	21	Revision F	10/24/01
Panel Wire Strip Glueing				
Anode Panels	5520-TR-333366	17	Revision C	10/24/01
Panel Wire Soldering (Machine)				
Anode Panels	5520-TR-333367	9	Revision C	10/24/01
Panel Component Soldering (Hand)				
Anode Panel	5520-TR-333253	21	Revision K	2/5/02
Upper Cathode Panels	5520-TR-333368	14	Revision I	2/5/02
Inner Cathode Panels	5520-TR-333429	13	Revision G	2/5/02
Lower Cathode Panels	5520-TR-333430	9	Revision C	10/24/01
Panel Tension Testing				
Anode Panel	5520-TR-333369	9	Revision C	1/29/02
Panel Electrical Testing				
Anode Panel	5520-TR-333254	11	Revision F	10/24/01

MP-9 – Chamber

Traveler Name	Traveler No. #	Pages	Status	Completion Date
Chamber Assembly				
Panel/Chamber Assy	5520-TR-333370	32	Revision Q	6/4/02
Chamber Capacitance	5520-TR-333479	9	Revision C	10/24/01
Chamber Test Training	5520-TR-333255	20	Revision H	2/7/02
Chamber Pack/Ship	5520-TR-333256	19	Revision C	11/8/01

Fermi National Accelerator Laboratory
Batavia, IL 60510

CMS GERBER MACHINE
ME234/2 ANODE PANEL ROUTING
TRAVELER

Reference Drawing(s)
CMS ME234/2 Anode Panel Assembly
MD-368221

CMS ME234/2 Anode Panel Artwork
ME-368225

Budget Code:	**Project Code:**
Released by: Bob Jensen	**Date:** JUL 12 2000
Prepared by: B. Jensen, P. Deering, J. Lindo, J. Wilson, M. Hubbard, L. Lee	

Title	Signature	Date
TD / E&F Process Engineering	Bob Jensen **Bob Jensen/Designee**	10/28/99
PPD Lab #8 Facility Manager	Phyllis L. Deering **Phyllis Deering/Designee**	10/29/99
Project Fabrication Manager	**Giorgio Apollinari/Designee**	10/29/99

Revision Page

Revision	Revision Description	TRR No.	Date
None	Initial Traveler Release	N/A	5/17/99
A	Step 4.1 Updated approved cleaning methods Step 6.0 New step added to incorporate alignment mark measurements at 11" &12". Renumbered steps after new step 6.0 Step 6.1 Added section for finish temperature and humidity. Step 6.2 Added computer file M22AFW. Updated router bit column. depth column made wider. Check off column made narrower. Name on M22ACS from Anode Front Wire changed to Anode Cathode strips. Step 7.0 Changed step 6.1 to step 7.1. Changed operation Anode to Anode Front Wire to Anode Cathode strips. Step 8.1 Added section for finish temperature and humidity. Step 8.2 Added router bit info. Made Depth column wider. Check off column made narrower. Step 10.3 New panel dwg added. Added removal of 'slivers'. Step 12.1 Added dwg. Update step to reflect tooling installation.	TRR0888	7/14/99
B	See marked-up copy attached to TRR	TRR0921	9/29/99
C	Step 8.2 Changed parameters of measurements from ends to side. Added new drawing. Step 12.1 Made measurements into a controlled document form to be added to traveler. Added additional two measurements on the panel wide end. STEP 6.1 CHANGED 6ZL6 M22 F4 TO M22 FID1.	TRR0924	10/27/99

Ensure appropriate memos and specific instructions are placed with the traveler before issuing the sub traveler binder to production.

1.0 General Notes

1.1 White (Lint Free) Gloves (Fermi stock 2250-1800) or Surgical Latex Gloves (Fermi stock 2250-2494) or equivalent, shall be worn by all personnel, as required, when handling all product parts after the parts have been prepared/cleaned.

1.2 All steps that require a sign-off shall include the Technician/Inspectors first initial and full last name.

1.3 No erasures or white out will be permitted to any documentation. All incorrectly entered data shall be corrected by placing a single line through the error, initial and date the error before adding the correct data.

1.4 All Discrepancy Reports issued shall be recorded in the left margin next to the applicable step.

1.5 All personnel performing steps in this traveler must have documented training for this traveler and associated operating procedures.

1.6 Personnel shall perform all tasks in accordance with current applicable ES&H guidelines and those specified within the step.

1.7 Cover the Chamber/Panel, as required, with green Herculite (Fermi stock 1740-0100) or equivalent, when not being serviced or assembled.

2.0 Panel Acquisition

Completed

2.1 Acquire one CMS ME234/2 Anode Panel (MD-368221). Verify the Panel Serial Number matches the serial number at the bottom right hand side of this traveler. ☒

W. Cahill
Technician(s)

7/31/00
Date

3.0 Gerber Machine Set-up/ Panel Loading

Completed

3.1 Vacuum the Routing surface of Gerber Machine surface to remove all dirt, dust and other foreign material which could damage or other wise prevent the panel from laying flat on the Gerber Routing surface. ☒

3.2 Visually inspect the Gerber Machine cutting surface and verify that the surface is clean. ☒

3.3 Locate the panel into the Gerber Machine Panel Alignment Pins and verify the panel is properly positioned with the serial number facing up. ☒

W. Curlil
Technician(s)

7/31/00
Date

4.0 Gerber Machine Set-Up

Completed

4.1 Install the router bit tool into the router head. Ensure the router bit tool is properly installed. Bring the router bit tool up to routing speed and visually re-inspect to ensure the router bit tool is still properly inserted. ☒

Note: Proper PPE must be worn during installing, testing, and operation Gerber Machine routing devices.

W. Curlil
Technician(s)

7/31/00
Date

5.0 Panel Routing

5.1 Record the Gerber Room Temperature and Humidity. Record the Date, process start time and finish time in the appropriate boxes below.

Note: Panel Front is the side that contains the panel serial number.

	Temperature in Degrees Fahrenheit	**Humidity in %**
Start	70.7 °F	63 %
Finish	70.7 °F	72 %

Date	**Time Started**	**Time Completed**
7/31/00	10:45 PM	8:45

8-1-00

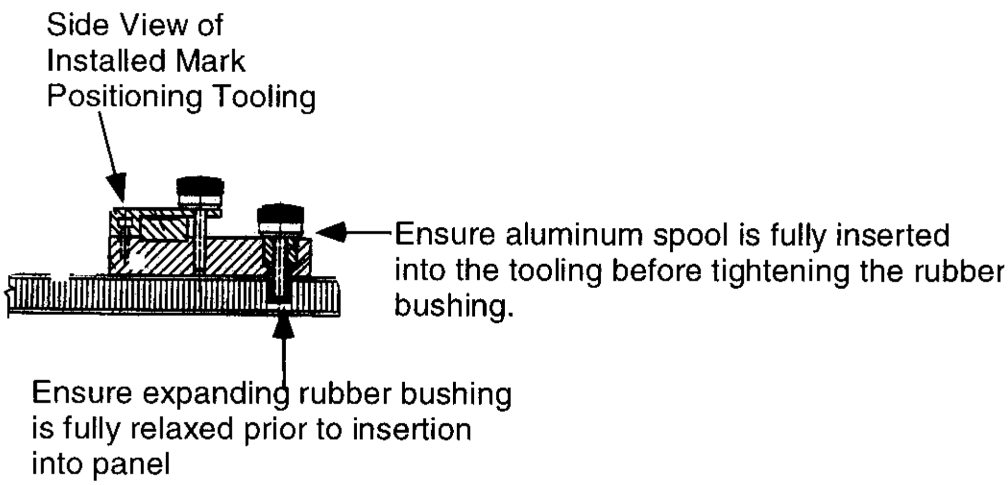
6.0 Panel Alignment Test Marks

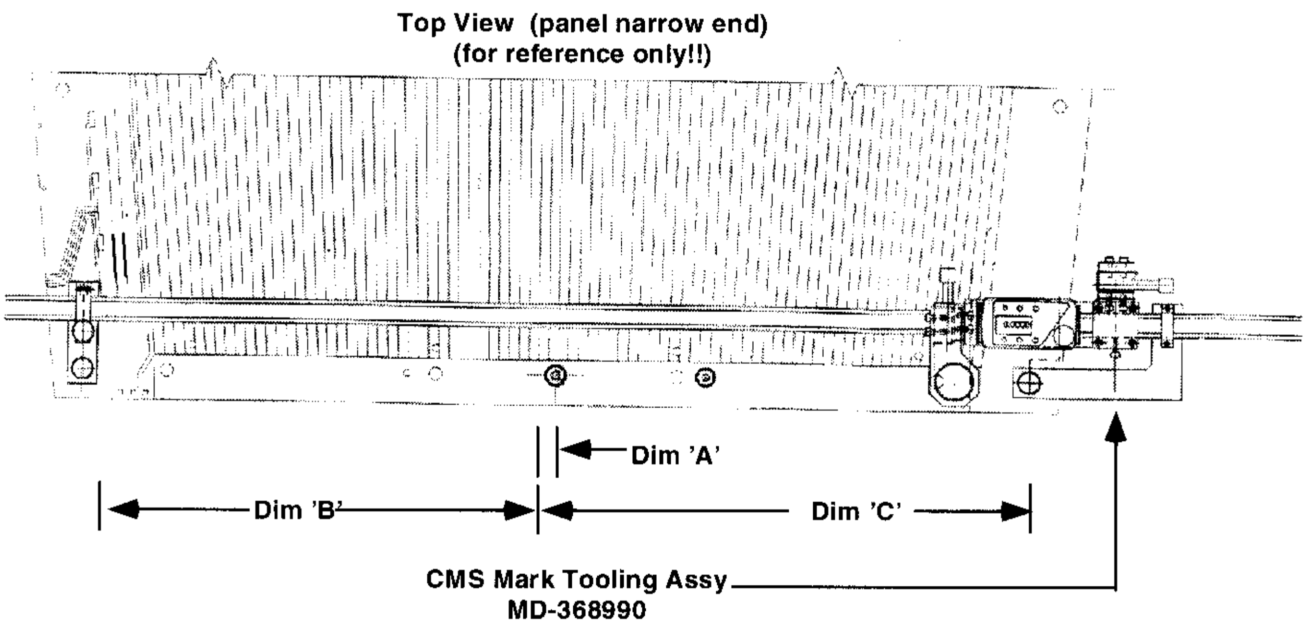
6.1 Route the panel Alignment Test Strips into the front of the Anode Panel in accordance with the below listed operations.

Computer File Name	**Router Bit Size/Type**				**Depth**	**Operation**	**Check -Off**
M22 Set 1 Indicate size w/✓	**0.063”**	✓	**0.125”**		.0075	**Inboard Positions 1, 4, 8, 12, & 16**	✓
M22 Set 2 Indicate size w/✓	**0.063”**		**0.125”**			**Inboard Positions 2, 5, 10, & 14**	
M22 Set 3 Indicate size w/✓	**0.063”**		**0.125”**			**Inboard Positions 3, 7, 11, & 14**	
M22 Set 4 Indicate size w/✓	**0.063”**		**0.125”**			**Outboard Positions 1, 4, 8, 12, & 16**	
M22 Set 5 Indicate size w/✓	**0.063”**		**0.125”**			**Outboard Positions 2, 5, 10, & 15**	
M22 Set 6 Indicate size w/✓	**0.063”**		**0.125”**			**Outboard Positions 3, 7, 11 & 14**	
M22 FID1	**0.063” bit w/ .010” flat**					**Fiducial Mark at 11”**	✓

Completed

6.2 Install the Mark Position Measuring Device Assembly (MD-368990) and perform the following measurements on the panel. When installing the Mark Positioning Tooling, ensure the expanding bushing is fully relaxed before installing into the panel. Also, ensure the aluminum spool is fully inserted into the tooling before tightening the rubber bushing. ☒





W. Cahill
Technician(s)

7/31/00
Date

6.3 Measure both sides of the 11" test strip mark with the Mark Position Assy tooling and record the measurement below. Once measured and recorded, calculate the average of the two measurements. Add measurement #1 to measurement #2, then divide by 2 to acquire your measurement average.

Measurement #1	10.9885
Measurement #2	11.0175
Measurement Total	22.0060
÷ 2	
Measurement Average	11.0030

If the above measurement average is within the range of 10.997" to 11.003", proceed to Step 7.0.

If the above measurement average is within the range of 10.990" to 11.010", proceed to Step 6.4

If the above measurement average is NOT within the range of 10.990" to 11.010", Contact your Supervisor Immediately!!!!

6.4 Using the measurement average obtained in Step 6.3, make an 'Off-Set' correction and record the new Gerber Machine 'Off-Set' number below. Then make an alignment test strip into the panel at 11½" on the narrow end of the panel.

6.5 Measure both sides of the 11½" test strip mark with the Mark Position Assy tooling and record the measurement below. Once measured and recorded, calculate the average of the two measurements. Add measurement #1 to measurement #2, then divide by 2 to acquire your measurement average.

Measurement #1	
Measurement #2	
Measurement Total	
÷ 2	
Measurement Average	

If the above measurement average is within the range of 11.497" to 11.503", proceed to Step 7.0.

If the above measurement average is NOT within the range of 11.497" to 11.503", Contact your <u>Supervisor Immediately!!!!</u>

______________________________ ______________________
Technician(s) Date

XX 6.6 If the above measurement average is NOT within the range of 11.497" to 11.503", Supervisor describe below corrective actions taken:

____
____
____
____

______________________________ ______________________
Lab #8 Facility Manager Date

7.0 Panel Routing

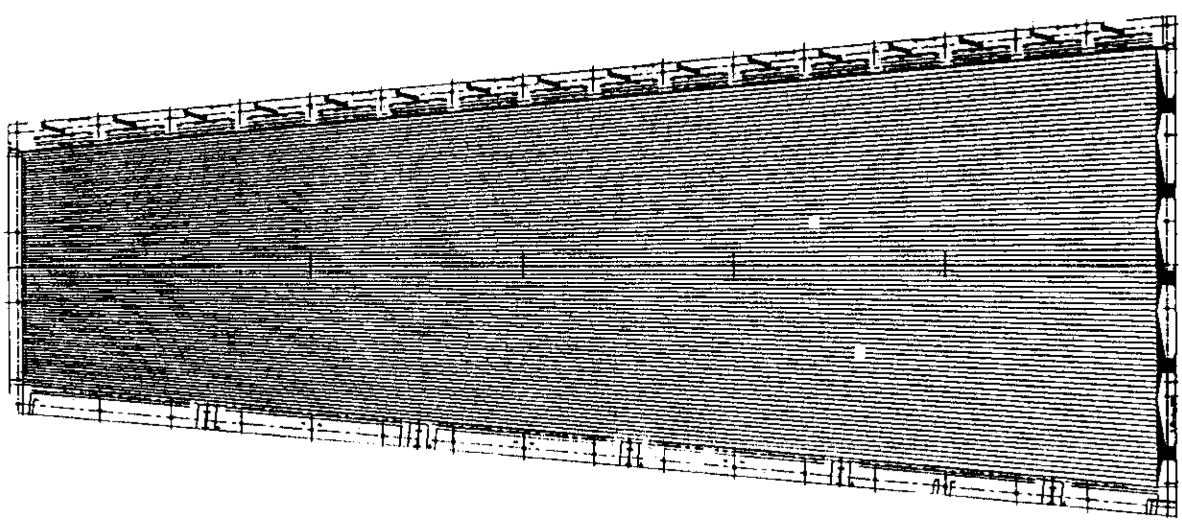
7.1 Route the front of the Anode Panel in accordance with CMS ME234/2 Anode Panel Artwork DWG ME-368225.

Computer File Name	Router Bit Size/Type	Depth	Operation	Check -Off
M22 A C S	**1/16" bit w/ .010" flat**	.0065	**Anode Cathode Strips**	✓
M22 A F W	**1/16" bit w/ .010" flat**	.004	**Anode Front Wire**	✓
M22 A F O	**1/16" bit w/ .010" flat**	.005	**Anode Front Outline (Clearout)**	✓
M22 A F C	**1/8" bit w/ .050" flat**	.009	**Anode Front HV (Clearout)**	✓
M22 A F G	**1/8" bit w/ .050" flat**	.006	**Anode Front Glueing**	✓

Technician(s) S. H[illegible] Date 8-1-00

8.0 Panel Inspection

8.1 After the routing of the panel front side has been completed, inspect the panel for skips (areas not cut) and note those areas in RED on the diagram below. Once noted, re-rout the panel as necessary to fully rout the panel. Record below the computer file name required and the new Groove Depth.



Computer File Name	Router Bit Size/Type	Depth	Operation	Check -Off
M22 A C S	**0.063" bit w/ .010" flat**		**Anode Cathode Strips**	
M22 A F W	**0.063" bit w/ .010" flat**		**Anode Front Wire**	
M22 A F O	**0.063" bit w/ .010" flat**		**Anode Front Outline (Clearout)**	
M22 A F C	**0.125" bit w/ .050" flat**		**Anode Front HV (Clearout)**	
M22 A F G	**0.125" bit w/ .050" flat**		**Anode Front Gluing**	

Comments:

Technician(s)

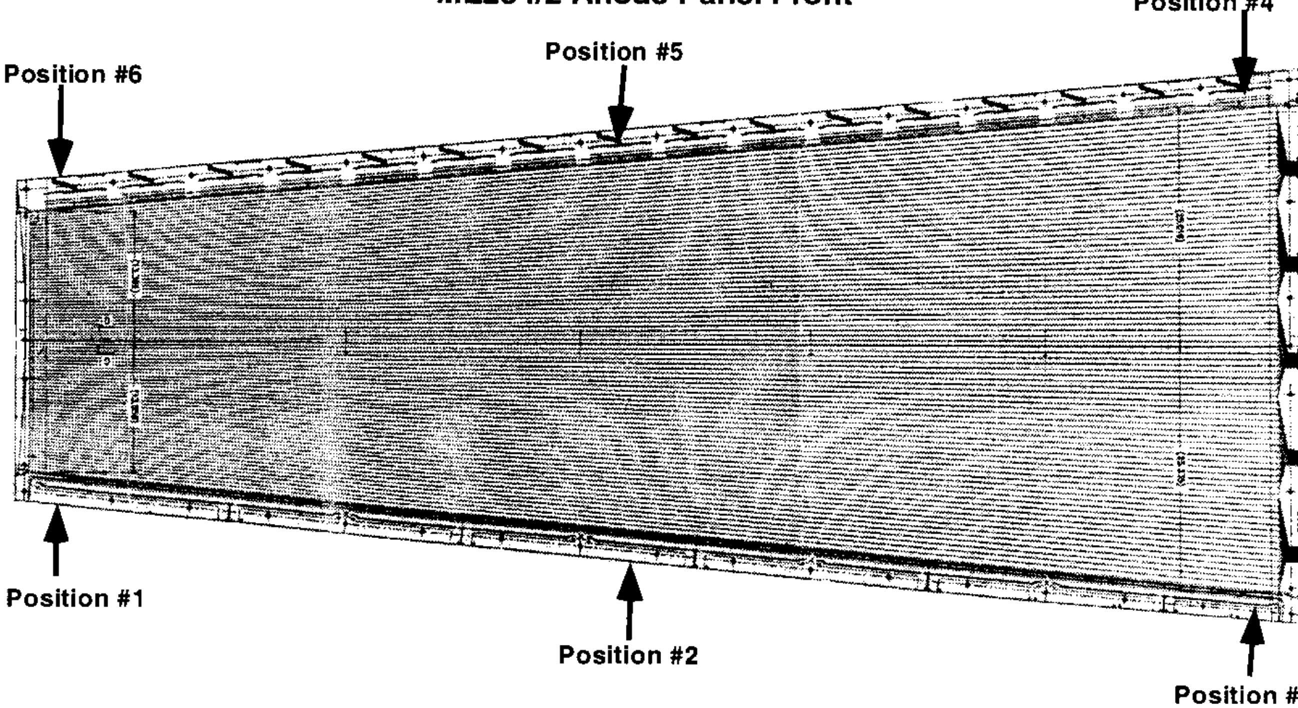
Date

Panel Serial Number ME234/2-A-297

8.2 Measure the groove depth after cutting. Record the measurements in the below boxes.

Note: Positions #1, #3, #4, and #6 are measured approximately 2" ± ½" in from the end of the routed strip.
Positions #2 and #5 are approximately within ± ½" of the routed strip mid-point.

ME234/2 Anode Panel Front



Position	Depth (in inches)
#1	.0075
#2	.007
#3	.007
#4	.005
#5	.0045
#6	.004

Technician(s) S. [signature]

Date 8-1-00

9.0 Gerber Machine Shut-Down/Panel Removal

			Completed
	9.1	Ensure the router head is in the 'home' position.	☒
	9.2	Vacuum all the panel cutting debris material from the panel and from the Gerber Machine.	☒
	9.3	Visually inspect the panel to ensure that all routing has been complete, there are no skips in the routings on the panel and the panel is acceptable to proceed.	
X		Panel Processed in accordance with artwork Dwg ME-368225.	☒
	9.4	Using approved lifting methods, rotate the panel 180° degrees. Relocate the panel into the alignment pins and secure panel to cutting surface.	☒

S. Lg
Technician(s)

8-1-00
Date

10.0 Panel Rear Routing

10.1 Record the Gerber Room Temperature and Humidity.

	Temperature in Degrees Fahrenheit	Humidity in %
Start	70.7 °F	69 %
Finish	70.7 °F	69 %

10.2 Rout the rear of the Anode Panel in accordance with CMS ME234/2 Anode Panel Artwork DWG ME-368225. Record the Date, process start time and finish time in the appropriate boxes below.

Note: The panel rear is opposite the side containing the panel serial number.

Date	Time Started	Time Completed
8-1-00	9:00	10:30

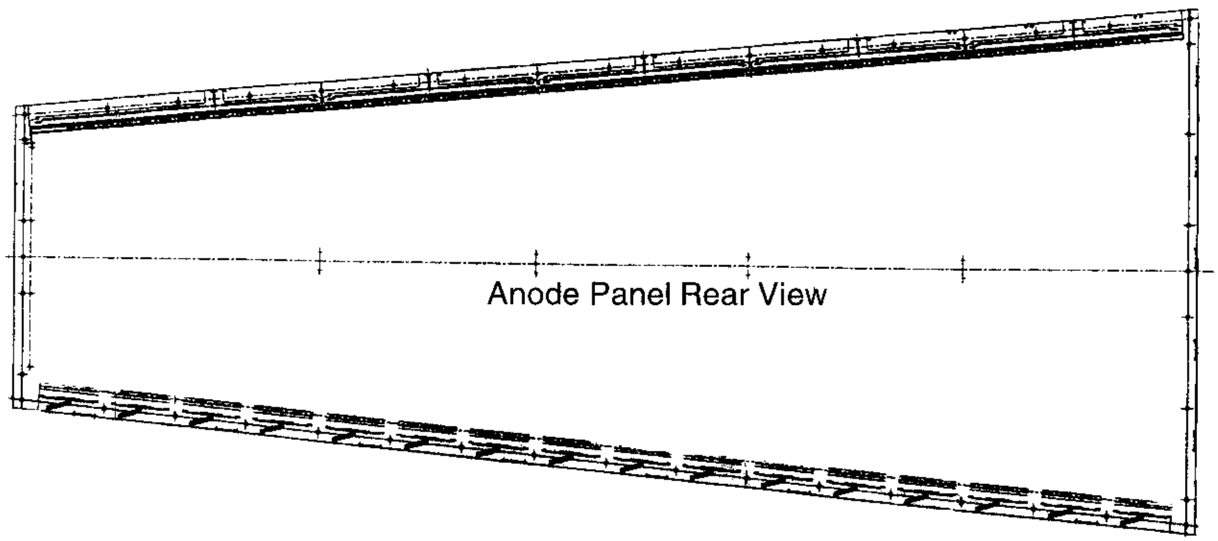
Computer File Name	Router Bit Size/Type				Depth	Operation	Check-(
M22 A R W	**1/16" bit w/.010" flat**				.004	**Anode Rear Wire**	✓
M22 A R O	**1/16" bit w/.010" flat**				.007	**Anode Rear Outline (Clearout)**	✓
M22 A R C	**1/8" bit w/.050" flat**				.0065	**Anode Rear HV (Clearout)**	✓
M22 A R G	**1/8" bit w/.050" flat**				.005	**Anode Rear Gluing**	✓
M22 Set 7 Indicate size w/✓	**0.063"**	X	**0.125"**		.007	**Inboard Positions 1, 4, 8, 12, & 16**	✓
M22 Set 8 Indicate size w/✓	**0.063"**		**0.125"**	X	.0055	**Inboard Positions 2, 5, 10, & 14**	✓
M22 Set 9 Indicate size w/✓	**0.063"**		**0.125"**			**Inboard Positions 3, 7, 11, & 14**	
M22 Set 10 Indicate size w/✓	**0.063"**		**0.125"**			**Outboard Positions 1, 4, 8, 12, & 16**	
M22 Set 11 Indicate size w/✓	**0.063"**		**0.125"**			**Outboard Positions 2, 5, 10, & 15**	
M22 Set 12 Indicate size w/✓	**0.063"**		**0.125"**			**Outboard Positions 3, 7, 11 & 14**	

S.L. ____________________
Technician(s)

8-1-00 ____________________
Date

10.3 After the routing of the panel rear side has been completed, inspect the panel for skips (areas not cut) and note those areas in RED on the diagram below. Once noted, re-rout the panel as necessary to fully rout the panel. Record below the computer file name required and the new Groove Depth.

Note: Special attention is needed to ensure that all 'slivers' of copper are removed after panel routing.



Computer File Name	Router Bit Size/Type				Depth	Operation	Check -Off
M22 A R W	**1/16" bit w/.010" flat**					**Anode Rear Wire**	
M22 A R O	**1/16" bit w/.010" flat**					**Anode Rear Outline (Clearout)**	
M22 A R C	**1/8" bit w/.050" flat**					**Anode Rear HV (Clearout)**	
M22 A R G	**1/8" bit w/.050" flat**					**Anode Rear Gluing**	
M22 Set 7 Indicate size w/✓	**0.063"**		**0.125"**			**Inboard Positions 1, 4, 8, 12, & 16**	
M22 Set 8 Indicate size w/✓	**0.063"**		**0.125"**			**Inboard Positions 2, 5, 10, & 14**	
M22 Set 9 Indicate size w/✓	**0.063"**		**0.125"**			**Inboard Positions 3, 7, 11, & 14**	
M22 Set 10 Indicate size w/✓	**0.063"**		**0.125"**			**Outboard Positions 1, 4, 8, 12, & 16**	
M22 Set 11 Indicate size w/✓	**0.063"**		**0.125"**			**Outboard Positions 2, 5, 10, & 15**	
M22 Set 12 Indicate size w/✓	**0.063"**		**0.125"**			**Outboard Positions 3, 7, 11 & 14**	

Comments:

____
____
____
____
____
____
____
____

________________________ Technician(s)

________________________ Date

11.0 Gerber Machine Shut-Down/Panel Removal

Completed

11.1 Ensure the routing head is in the 'home' position. ☑

11.2 Vacuum all the panel routing debris material from the panel and from the Gerber Machine. ☒

11.3 Using approved lifting methods, transport the panel to the measurement/staging/storage area. Transport the panel in a manner to prevent damage to the panel. ☑

Technician(s) S.L.J.

Date 8-1-00

Panel Serial Number ME234/2-A-297

TS/Engineering and Fabrication

Specification # 5520-FM-333394
November 5, 1999
Rev A

CMS INNER CATHODE PANEL

7	-17.1610
8	-17.1865

9	16.8410
10	16.8670

Panel Wide End

23	0.9845
24	1.0090

11	24.4390
12	24.4645

5	-25.3915
6	-25.4210

25	1.0095
26	0.9850

11" Mark

19	10.9895
20	11.0180

11.5" Mark

21	
22	

Panel Narrow End

3	-13.2195
4	-13.2440

15	-0.9855
16	-1.0105

1	13.4135
2	13.3870

13	-5.9875
14	-6.0135

17	6.0135
18	5.9870

This form to be added to the CMS ME234/2 Gerber Inner Cathode Panel Routing Traveler 5520-TR-333360 by below Panel Serial Number when completed.

S. Huey
Technician(s)

8-1-00
Date

CMS ME234/2 Inner Cathode Measurement Form

Panel Serial No 234/2-A-29

Revision Page

Revision	Step No.	Revision Description	TRR No.	Date
None	N/A	Initial Release	N/A	10/27/99
A		Added box for 11.5" measurement. Added numbers to boxes for data entry.	0938	11/5/99

12.0 Panel Measurement

Completed

12.1 Install the Mark Position Measuring Device Assembly (MD-368990) onto the panel. ☐

Measure the panel and record the measurements on Measurement Form 5520-FM-333392 and attach the completed form to this traveler. ☐

When installing the Mark Positioning Tooling, ensure the expanding bushing is fully relaxed before installing into the panel. Also, ensure the aluminum spool is fully inserted into the tooling before tightening the rubber bushing.

Technician(s) ____________________ Date ____________________

13.0 Panel Inspection

13.1 Visually inspect the panel to ensure that all routing has been complete, there are no skips in the routings on the panel and the panel is acceptable to proceed.

Note: Special attention is needed to ensure all routed areas are free of 'slivers' and that areas where copper is removed is free of copper.

X Panel Processed in accordance with artwork Dwg ME-368225. ☐

Lead Technician(s) ____________________ Date ____________________

13.2 Transport the panel to the panel staging/shipping area for further processing.

Technician(s) ____________________ Date ____________________

14.0 Production Complete

XXX 14.1 Process Engineering verify that the CMS Gerber Machine ME234/2 Anode Panel Routing (5520-TR-333357) is accurate and complete. This shall include a review of all steps to ensure that all operations have been completed and signed off. Ensure that all Discrepancy Reports, Nonconformance Reports, Repair/Rework Forms, Deviation Index, Revision Requests and dispositions have been reviewed by the Responsible Authority for conformance before being approved.

Comments:

[signature] 8/1/00

Process Engineering/Designee   Date

15.0 Attach the Process Engineering "OK to Proceed" Tag on the panel.

[signature]

Process Engineering/Designee   Date

16.0 Proceed to the next major assembly operation as required.

Fermi National Accelerator Laboratory
Batavia, IL 60510

CMS GERBER MACHINE ME234/2 ANODE PANEL ROUTING TRAVELER

Reference Drawing(s)
CMS ME234/2 Anode Panel Assembly
MD-368221

CMS ME234/2 Anode Panel Artwork
ME-368225

Budget Code:	**Project Code:**
Released by: Bob Jensen	**Date:** JUL 20 2000

Prepared by: B. Jensen, P. Deering, J. Lindo, J. Wilson, M. Hubbard, L. Lee

Title	Signature	Date
TD / E&F Process Engineering	Bob Jensen Bob Jensen/Designee	10/28/99
PPD Lab #8 Facility Manager	Phyllis L. Deering Phyllis Deering/Designee	10/29/99
Project Fabrication Manager	Apollinari Giorgio Apollinari/Designee	10/29/99

Panel Serial Number ME234/2-A-311

Revision Page

Revision	Revision Description	TRR No.	Date
None	Initial Traveler Release	N/A	5/17/99
A	Step 4.1 Updated approved cleaning methods Step 6.0 New step added to incorporate alignment mark measurements at 11" &12". Renumbered steps after new step 6.0 Step 6.1 Added section for finish temperature and humidity. Step 6.2 Added computer file M22AFW. Updated router bit column. depth column made wider. Check off column made narrower. Name on M22ACS from Anode Front Wire changed to Anode Cathode strips. Step 7.0 Changed step 6.1 to step 7.1. Changed operation Anode to Anode Front Wire to Anode Cathode strips. Step 8.1 Added section for finish temperature and humidity. Step 8.2 Added router bit info. Made Depth column wider. Check off column made narrower. Step 10.3 New panel dwg added. Added removal of 'slivers'. Step 12.1 Added dwg. Update step to reflect tooling installation.	TRR0888	7/14/99
B	See marked-up copy attached to TRR	TRR0921	9/29/99
C	Step 8.2 Changed parameters of measurements from ends to side. Added new drawing. Step 12.1 Made measurements into a controlled document form to be added to traveler. Added additional two measurements on the panel wide end. STEP 6.1 CHANGED FILE M22 FW TO M22 FID1.	TRR0924	10/27/99

Ensure appropriate memos and specific instructions are placed with the traveler before issuing the sub traveler binder to production.

1.0 General Notes

1.1 White (Lint Free) Gloves (Fermi stock 2250-1800) or Surgical Latex Gloves (Fermi stock 2250-2494) or equivalent, shall be worn by all personnel, as required, when handling all product parts after the parts have been prepared/cleaned.

1.2 All steps that require a sign-off shall include the Technician/Inspectors first initial and full last name.

1.3 No erasures or white out will be permitted to any documentation. All incorrectly entered data shall be corrected by placing a single line through the error, initial and date the error before adding the correct data.

1.4 All Discrepancy Reports issued shall be recorded in the left margin next to the applicable step.

1.5 All personnel performing steps in this traveler must have documented training for this traveler and associated operating procedures.

1.6 Personnel shall perform all tasks in accordance with current applicable ES&H guidelines and those specified within the step.

1.7 Cover the Chamber/Panel, as required, with green Herculite (Fermi stock 1740-0100) or equivalent, when not being serviced or assembled.

2.0 Panel Acquisition

Completed

2.1 Acquire one CMS ME234/2 Anode Panel (MD-368221). Verify the Panel Serial Number matches the serial number at the bottom right hand side of this traveler. ☑

D. Wilson
Technician(s)

8/17/00
Date

3.0 Gerber Machine Set-up/ Panel Loading

Completed

3.1 Vacuum the Routing surface of Gerber Machine surface to remove all dirt, dust and other foreign material which could damage or other wise prevent the panel from laying flat on the Gerber Routing surface. ☑

3.2 Visually inspect the Gerber Machine cutting surface and verify that the surface is clean. ☑

3.3 Locate the panel into the Gerber Machine Panel Alignment Pins and verify the panel is properly positioned with the serial number facing up. ☑

Technician(s) ____________ Date 8/17/00

4.0 Gerber Machine Set-Up

Completed

4.1 Install the router bit tool into the router head. Ensure the router bit tool is properly installed. Bring the router bit tool up to routing speed and visually re-inspect to ensure the router bit tool is still properly inserted. ☑

Note: Proper PPE must be worn during installing, testing, and operation Gerber Machine routing devices.

Technician(s) ____________ Date 8/17/00

5.0 Panel Routing

5.1 Record the Gerber Room Temperature and Humidity. Record the Date, process start time and finish time in the appropriate boxes below.

Note: Panel Front is the side that contains the panel serial number.

	Temperature in Degrees Fahrenheit	Humidity in %
Start	68.9 °F	66 %
Finish	70.7 °F	61 %

Date	Time Started	Time Completed
8/17/00	3:00 PM	5:55 PM

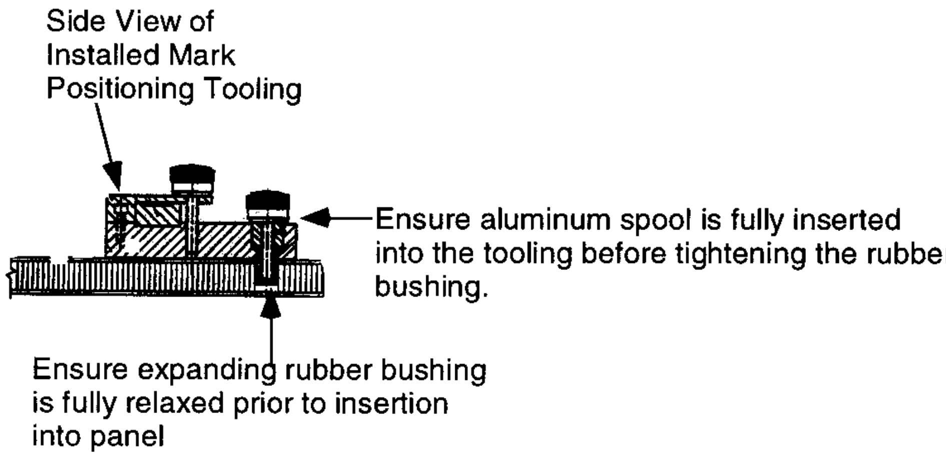
6.0 Panel Alignment Test Marks

6.1 Route the panel Alignment Test Strips into the front of the Anode Panel in accordance with the below listed operations.

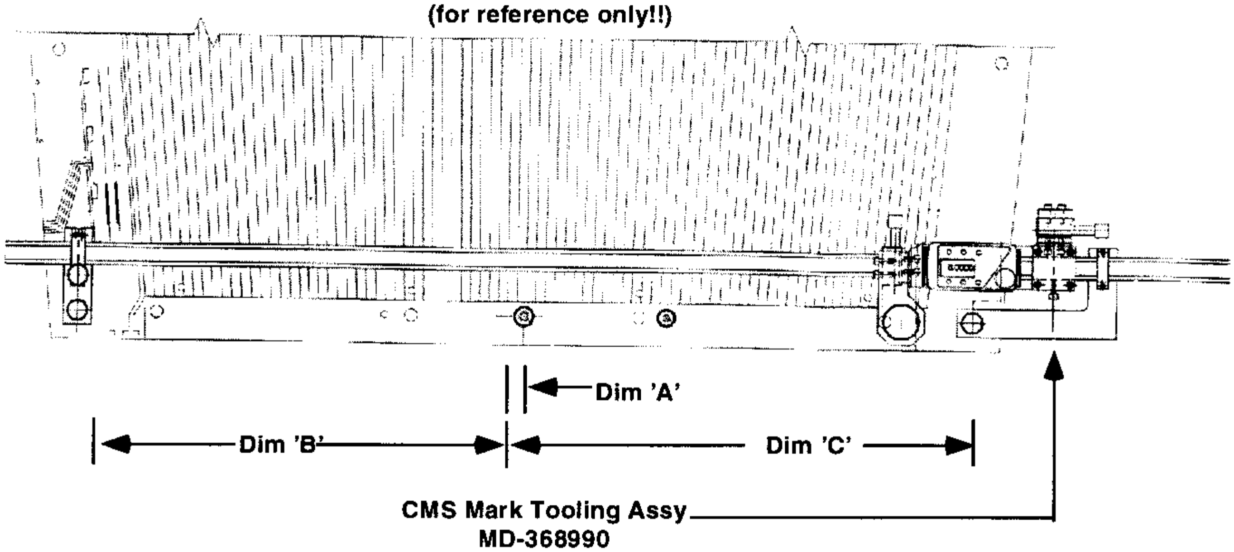
Computer File Name	Router Bit Size/Type				Depth	Operation	Check -Off
M22 Set 1 Indicate size w/✓	0.063"	✓	0.125"		.0075	Inboard Positions 1, 4, 8, 12, & 16	✓
M22 Set 2 Indicate size w/✓	0.063"		0.125"	✓	.0075	Inboard Positions 2, 5, 10, & 14	✓
M22 Set 3 Indicate size w/✓	0.063"		0.125"			Inboard Positions 3, 7, 11, & 14	
M22 Set 4 Indicate size w/✓	0.063"		0.125"			Outboard Positions 1, 4, 8, 12, & 16	
M22 Set 5 Indicate size w/✓	0.063"		0.125"			Outboard Positions 2, 5, 10, & 15	
M22 Set 6 Indicate size w/✓	0.063"		0.125"			Outboard Positions 3, 7, 11 & 14	
M22 FID1	0.063" bit w/ .010" flat					Fiducial Mark at 11"	✓

Completed

6.2 Install the Mark Position Measuring Device Assembly (MD-368990) and perform the following measurements on the panel. When installing the Mark Positioning Tooling, ensure the expanding bushing is fully relaxed before installing into the panel. Also, ensure the aluminum spool is fully inserted into the tooling before tightening the rubber bushing.



Top View (panel narrow end)
(for reference only!!)



W. Cahill
Technician(s)

8/17/00
Date

6.3 Measure both sides of the 11" test strip mark with the Mark Position Assy tooling and record the measurement below. Once measured and recorded, calculate the average of the two measurements. Add measurement #1 to measurement #2, then divide by 2 to acquire your measurement average.

Measurement #1	10.9860
Measurement #2	11.0170
Measurement Total	22.0030
÷ 2	
Measurement Average	11.0015

If the above measurement average is within the range of 10.997" to 11.003", proceed to Step 7.0.

If the above measurement average is within the range of 10.990" to 11.010", proceed to Step 6.4

If the above measurement average is NOT within the range of 10.990" to 11.010", Contact your Supervisor Immediately!!!!

6.4 Using the measurement average obtained in Step 6.3, make an 'Off-Set' correction and record the new Gerber Machine 'Off-Set' number below. Then make an alignment test strip into the panel at 11½" on the narrow end of the panel.

6.5 Measure both sides of the 11½" test strip mark with the Mark Position Assy tooling and record the measurement below. Once measured and recorded, calculate the average of the two measurements. Add measurement #1 to measurement #2, then divide by 2 to acquire your measurement average.

Measurement #1	
Measurement #2	
Measurement Total	
÷ 2	
Measurement Average	

If the above measurement average is within the range of 11.497" to 11.503", proceed to Step 7.0.

If the above measurement average is NOT within the range of 11.497" to 11.503", Contact your <u>Supervisor Immediately!!!!</u>

____________________________ ________________________

Technician(s) Date

XX 6.6 If the above measurement average is NOT within the range of 11.497" to 11.503", Supervisor describe below corrective actions taken:

____

____

____

____

____________________________ ________________________

Lab #8 Facility Manager Date

7.0 Panel Routing

7.1 Route the front of the Anode Panel in accordance with CMS ME234/2 Anode Panel Artwork DWG ME-368225.

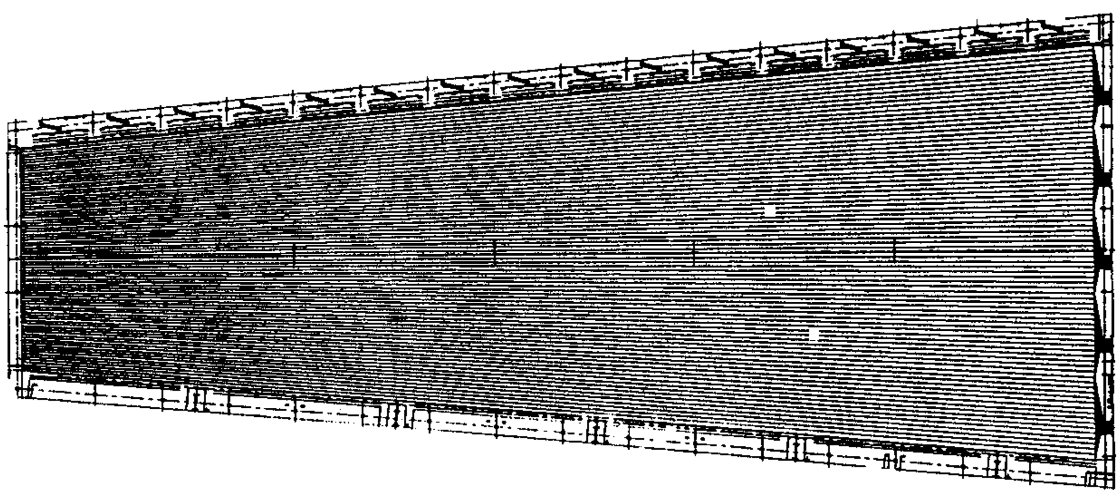
Computer File Name	Router Bit Size/Type	Depth	Operation	Check -Off
M22 A C S	**1/16" bit w/ .010" flat**	~~.0075~~ .005	**Anode Cathode Strips**	✓
M22 A F W	**1/16" bit w/ .010" flat**	.0045	**Anode Front Wire**	✓
M22 A F O	**1/16" bit w/ .010" flat**	.006	**Anode Front Outline (Clearout)**	✓
M22 A F C	**1/8" bit w/ .050" flat**	.0085	**Anode Front HV (Clearout)**	✓
M22 A F G	**1/8" bit w/ .050" flat**	.0075	**Anode Front Glueing**	✓

W. Cahl
Technician(s)

8/17/00
Date

8.0 Panel Inspection

8.1 After the routing of the panel front side has been completed, inspect the panel for skips (areas not cut) and note those areas in RED on the diagram below. Once noted, re-rout the panel as necessary to fully rout the panel. Record below the computer file name required and the new Groove Depth.



Panel Serial Number ME234/2-A-311

Computer File Name	Router Bit Size/Type	Depth	Operation	Check -Off
M22 A C S	**0.063" bit w/ .010" flat**		**Anode Cathode Strips**	
M22 A F W	**0.063" bit w/ .010" flat**		**Anode Front Wire**	
M22 A F O	**0.063" bit w/ .010" flat**		**Anode Front Outline (Clearout)**	
M22 A F C	**0.125" bit w/ .050" flat**		**Anode Front HV (Clearout)**	
M22 A F G	**0.125" bit w/ .050" flat**		**Anode Front Gluing**	

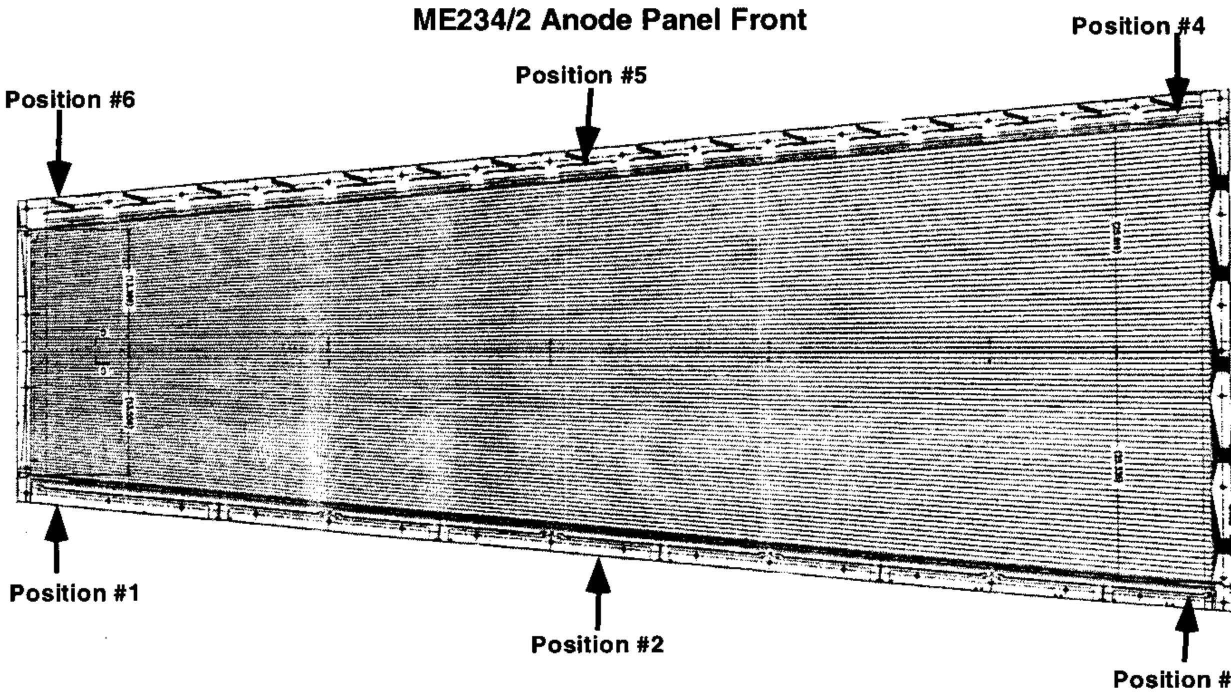
Comments:

Technician(s)

Date

8.2 Measure the groove depth after cutting. Record the measurements in the below boxes.

Note: Positions #1, #3, #4, and #6 are measured approximately 2" ± ½" in from the end of the routed strip.
Positions #2 and #5 are approximately within ± ½" of the routed strip mid-point.



Position	Depth (in inches)
#1	.0075
#2	.0075
#3	.0075
#4	.0055
#5	.005
#6	.005

W. [signature]
Technician(s)

Date 8/17/00

9.0 Gerber Machine Shut-Down/Panel Removal

		Completed
9.1	Ensure the router head is in the 'home' position.	☑
9.2	Vacuum all the panel cutting debris material from the panel and from the Gerber Machine.	☑
9.3	Visually inspect the panel to ensure that all routing has been complete, there are no skips in the routings on the panel and the panel is acceptable to proceed.	
X	Panel Processed in accordance with artwork Dwg ME-368225.	☑
9.4	Using approved lifting methods, rotate the panel 180° degrees. Relocate the panel into the alignment pins and secure panel to cutting surface.	☑

W. Cal[illegible]
Technician(s)

8/17/00
Date

10.0 Panel Rear Routing

10.1 Record the Gerber Room Temperature and Humidity.

	Temperature in Degrees Fahrenheit	Humidity in %
Start	70.7 °F	63 %
Finish	69.8 °F	56 %

10.2 Rout the rear of the Anode Panel in accordance with CMS ME234/2 Anode Panel Artwork DWG ME-368225. Record the Date, process start time and finish time in the appropriate boxes below.

Note: The panel rear is opposite the side containing the panel serial number.

Date	Time Started	Time Completed
8/17/00	6:05 PM	7:55 PM

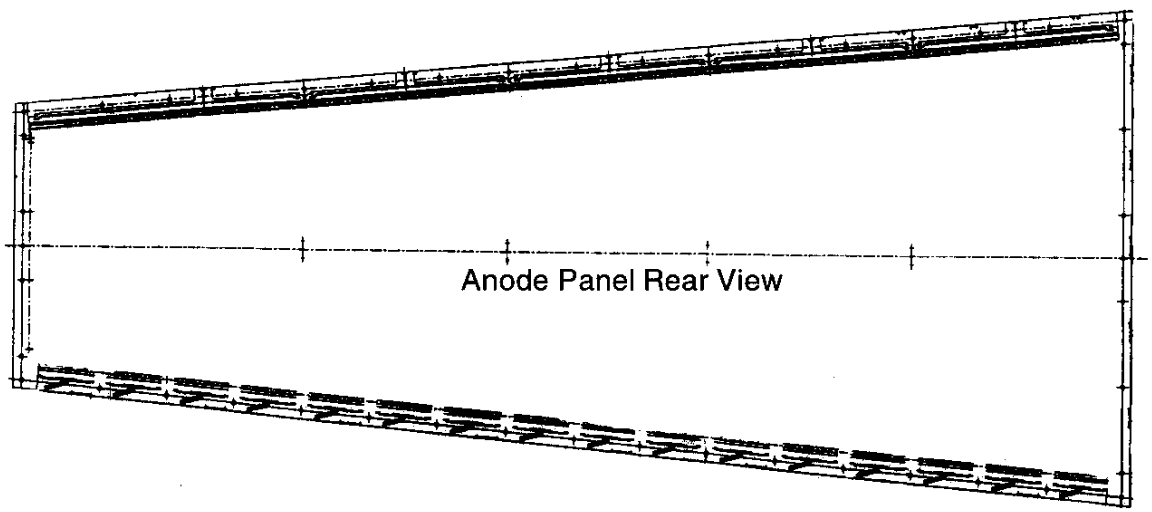
Computer File Name	Router Bit Size/Type				Depth	Operation	Check-Off
M22 A R W	1/16" bit w/.010" flat				.006	Anode Rear Wire	✓
M22 A R O	1/16" bit w/.010" flat				.007	Anode Rear Outline (Clearout)	✓
M22 A R C	1/8" bit w/.050" flat				.0085	Anode Rear HV (Clearout)	✓
M22 A R G	1/8" bit w/.050" flat				.007	Anode Rear Gluing	✓
M22 Set 7 Indicate size w/✓	0.063"	✓	0.125"		.006	Inboard Positions 1, 4, 8, 12, & 16	✓
M22 Set 8 Indicate size w/✓	0.063"		0.125"	✓	.0075	Inboard Positions 2, 5, 10, & 14	✓
M22 Set 9 Indicate size w/✓	0.063"		0.125"			Inboard Positions 3, 7, 11, & 14	
M22 Set 10 Indicate size w/✓	0.063"		0.125"			Outboard Positions 1, 4, 8, 12, & 16	
M22 Set 11 Indicate size w/✓	0.063"		0.125"			Outboard Positions 2, 5, 10, & 15	
M22 Set 12 Indicate size w/✓	0.063"		0.125"			Outboard Positions 3, 7, 11 & 14	

W. Cahill
Technician(s)

8/17/00
Date

10.3 After the routing of the panel rear side has been completed, inspect the panel for skips (areas not cut) and note those areas in RED on the diagram below. Once noted, re-rout the panel as necessary to fully rout the panel. Record below the computer file name required and the new Groove Depth.

Note: Special attention is needed to ensure that all 'slivers' of copper are removed after panel routing.



Computer File Name	Router Bit Size/Type				Depth	Operation	Check -Off
M22 A R W	**1/16" bit w/.010" flat**				~~.006~~ W.G.	**Anode Rear Wire**	✓
M22 A R O	**1/16" bit w/.010" flat**				8/17/00 .007	**Anode Rear Outline (Clearout)**	✓
M22 A R C	**1/8" bit w/.050" flat**					**Anode Rear HV (Clearout)**	
M22 A R G	**1/8" bit w/.050" flat**					**Anode Rear Gluing**	
M22 Set 7 Indicate size w/✓	**0.063"**		**0.125"**			**Inboard Positions 1, 4, 8, 12, & 16**	
M22 Set 8 Indicate size w/✓	**0.063"**		**0.125"**			**Inboard Positions 2, 5, 10, & 14**	
M22 Set 9 Indicate size w/✓	**0.063"**		**0.125"**			**Inboard Positions 3, 7, 11, & 14**	
M22 Set 10 Indicate size w/✓	**0.063"**		**0.125"**			**Outboard Positions 1, 4, 8, 12, & 16**	
M22 Set 11 Indicate size w/✓	**0.063"**		**0.125"**			**Outboard Positions 2, 5, 10, & 15**	
M22 Set 12 Indicate size w/✓	**0.063"**		**0.125"**			**Outboard Positions 3, 7, 11 & 14**	

Comments:

____
____
____
____
____
____
____
____

Technician(s) ____________________ Date ____________________

Panel Serial Number ME234/2-A-311

11.0 Gerber Machine Shut-Down/Panel Removal

		Completed
11.1	Ensure the routing head is in the 'home' position.	☑
11.2	Vacuum all the panel routing debris material from the panel and from the Gerber Machine.	☑
11.3	Using approved lifting methods, transport the panel to the measurement/staging/storage area. Transport the panel in a manner to prevent damage to the panel.	☑

W. [signature]
Technician(s)

8/17/00
Date

CMS ANODE PANEL

7	-17.1840
8	-17.1555

9	16.8440
10	16.8695

0

Panel Wide End

23	0.9900
24	1.0100

11	24.4420
12	24.4680

5	-25.4190
6	-25.3875

25	0.9905
26	1.0100

11" Mark

19	10.9880
20	11.0185

11.5" Mark

21	
22	

0

Panel Narrow End

3	-13.2455
4	-13.2175

15	-1.0120
16	-0.9840

1	13.3890
2	13.4195

13	-6.0140
14	-5.9860

17	5.9885
18	6.0170

This form to be added to the CMS ME234/2 Gerber Anode Panel Routing Traveler 5520-TR-333357 by below Panel Serial Number when completed.

W. [illegible]
Technician(s)

8/17/00
Date

Panel Serial No: 234/2-A-311

Revision Page

Revision	Step No.	Revision Description	TRR No.	Date
None	N/A	Initial Release	N/A	10/27/99
A		Added box for 11.5" measurement. Added numbers to boxes for data entry.	0936	11/5/99

12.0 Panel Measurement

Completed

12.1 Install the Mark Position Measuring Device Assembly (MD-368990) onto the panel. ☑

Measure the panel and record the measurements on Measurement Form 5520-FM-333392 and attach the completed form to this traveler. ☑

When installing the Mark Positioning Tooling, ensure the expanding bushing is fully relaxed before installing into the panel. Also, ensure the aluminum spool is fully inserted into the tooling before tightening the rubber bushing.

W. Cull
Technician(s)

8/17/00
Date

13.0 Panel Inspection

13.1 Visually inspect the panel to ensure that all routing has been complete, there are no skips in the routings on the panel and the panel is acceptable to proceed.

Note: Special attention is needed to ensure all routed areas are free of 'slivers' and that areas where copper is removed is free of copper.

X Panel Processed in accordance with artwork Dwg ME-368225. ☑

W. Cull
Lead Technician(s)

8/17/00
Date

13.2 Transport the panel to the panel staging/shipping area for further processing.

W. Cull
Technician(s)

8/17/00
Date

14.0 Production Complete

XXX 14.1 Process Engineering verify that the CMS Gerber Machine ME234/2 Anode Panel Routing (5520-TR-333357) is accurate and complete. This shall include a review of all steps to ensure that all operations have been completed and signed off. Ensure that all Discrepancy Reports, Nonconformance Reports, Repair/Rework Forms, Deviation Index, Revision Requests and dispositions have been reviewed by the Responsible Authority for conformance before being approved.

Comments:

____

[signature] 8/17/00
Process Engineering/Designee Date

15.0 Attach the Process Engineering "OK to Proceed" Tag on the panel.

N/A
Process Engineering/Designee Date

16.0 Proceed to the next major assembly operation as required.

Fermi National Accelerator Laboratory
Batavia, IL 60510

CMS ME234/2 ANODE PANEL WIRE WINDING TRAVELER

Reference Drawing(s)

Endcap Muon Chamber ME234/2 Final Assy
5520-ME-368220

Endcap Muon Chamber ME234/2 Anode Panel Assy
5220-ME-368221

Endcap Muon Chamber ME234/2 Anode Panel
5220-ME-368225

Budget Code:	**Project Code:**
Released by: Pamela Isham	**Date:** JUN 25 2001
Prepared by: B. Jensen, M. Hubbard, L. Lee P. Isham	

Title	Signature	Date
TD / E&F Process Engineering	Bob Jensen (signed) Bob Jensen/Designee	3 Apr '01
TD / E&F Assembly	(signed) Glenn Smith/Designee	4-3-01
TD / E&F Technological Physicist	(signed) Oleg Prokofiev/Designee	04/03/01
TD / CMS Project Manager	Apollinari (signed) Giorgio Apollinari/Designee	4/3/01

Revision Page

Revision	Step No.	Revision Description	TRR No.	Date
None	N/A	Initial Release	N/A	02/08/00
A		Changed the arrow for "Panel Serial Number End" on drawing on page 7.	0967	05/31/00
	6.4	Moved step 6.8 to 6.4		
	7.2	Changed Gauge setting from 250g to 260 g.		
	8.4	Added steps 8.4.1, 8.4.2 and added new drawing.		
	8.9	Added step 8.9.		
	8.11,8.12	Added steps 8.11 and 8.12 and added new drawing.		
B	4.7	Added step 4.7 and info box.	1012	07/24/00
	8.8	Added step for broken wire procedure and chart.		
	8.9	Changed 'information on the' to 'information from the'		
	8.9	Changed 'in Step 5.6' to 'in Step 8.11 panel diagram'		
	8.10,8.11	Reworded steps for clarification, and changed "Break" to "Double" in chart.		
	8.16	Rewrote step to ensure proper wire spool marking.		
C	4.2	Removed signature line.	1061	09/28/00
	6.2	Adjusted info box to reflect procedure used on the Production Floor.		
	6.10	Added side designation check boxes and Wire #'s.		
	6.11	Added side designation check boxes and Wire #'s.		
D	8.14	Added step to visually inspect wires after wire winding is done.	1108	01/15/01
E	8.5	Changed from turn on panel rotation to turn on tension	1140	4/2/01

Ensure appropriate memos and specific instructions are placed with the traveler before issuing the sub traveler binder to production.

1.0 General Notes

1.1 White (Lint Free) Gloves (Fermi stock 2250-1800) or Nitrile Gloves (Fermi stock 2250-2040) or equivalent shall be worn by all personnel, as required, when handling all product parts after the parts have been prepared/cleaned.

1.2 All steps that require a sign-off shall include the Technician/Inspectors first initial and full last name.

1.3 No erasures or white out will be permitted to any documentation. All incorrectly entered data shall be corrected by placing a single line through the error, initial and date the error before adding the correct data.

1.4 All Discrepancy Reports issued shall be recorded in the left margin next to the applicable step.

1.5 All personnel performing steps in this traveler must have documented training for this traveler and associated operating procedures.

1.6 Personnel shall perform all tasks in accordance with current applicable ES&H guidelines and those specified within the step.

1.7 Cover the panel/chamber, as required, with Mylar or approved material when not being serviced or assembled.

1.8 Never hand pass anything over a panel, damage could occur.

2.0 Parts Kit List

2.1 Attach the completed Parts Kit List for the CMS ME234/2 Panel Wire Winding to this traveler. Ensure that the serial number on the Parts Kit List matches the serial number of this traveler. Verify that the Parts Kit received are complete.

Process Engineering/Designee Date

3.0 Panel Acquisition

Completed

3.1 Acquire the Anode (ME-368225) panel as per the serial number listed in the footer, right side of this traveler. ☑

3.2 Visually check the panel for damage which is to include but not limited to scratches/gouges in the copper, damage to the sides and/or corners. ☑

Helen Jensen
Technician(s)

7/16/01
Date

4.0 Panel Tooling Installation

Completed

4.1 Install onto the Anode Panel the following Anode Panel Support Assembly tooling per dwg MD-368812.

Note: Insure that the screws holding the notched brackets are inserted into the panel from the side opposite to the strips (side opposite to the serial number).

Narrow End Part No.	Description	Qty
MB-368817	Trunion Bracket S.E.	1 ea
MA-368819	Notched Bracket Plate, LT	2 ea
MA-368820	Notched Bracket Plate, RT	2 ea
MA-368821	Centering Sleeve	4 ea
MA-368822	Bracket Nut	4 ea
N/A	10-32 X1 Flat Cap Screw	4 ea
N/A	10-32 X .375 Flat Cap Screw	8 ea
N/A	¼-20 X .625 Flat Head	4 ea
MA-368813	Trunion Assembly	1 ea

Wide End Part No.	Description	Qty
MB-368816	Trunion Bracket, L.E.	1 ea
MA-368818	Bracket Plate	12 ea
MA-368820	Notched Bracket Plate, RT	2 ea
MA-368822	Bracket Nut	4 ea
N/A	10-32 X 1 Flat Cap Screw	4 ea
N/A	10-32 X .375 Flat Cap Screw	8 ea
N/A	¼-20 X .625 Flat Head	4 ea
MA-368821	Centering Sleeve	4 ea
MA-368813	Trunion Assembly	1 ea

Helen Jensen
Technician(s)

7/16/01
Date

4.2 Install the panel onto the Panel Transport Cart Assembly (MD-368800) ☑

4.3 Install onto the panel the following Anode Panel Wire Winding Guide Tooling per dwg MD-368950.

Narrow End Part Number	**Description**	**Qty**
MA-368968	Bar	2 ea
MA-368969	Plate	2 ea
MA-368971	Plate	2 ea
N/A	10-24 X .375" Socket HD Screw	
N/A	¼" Flat Washer	

Wide End Part Number	**Description**	**Qty**
MA-368962	Plate	2 ea
MA-368963	Bar	2 ea
MA-368964	Plate	2 ea
Blank		
Blank		

Helen Jeuell
Technician(s)

7/16/01
Date

Completed

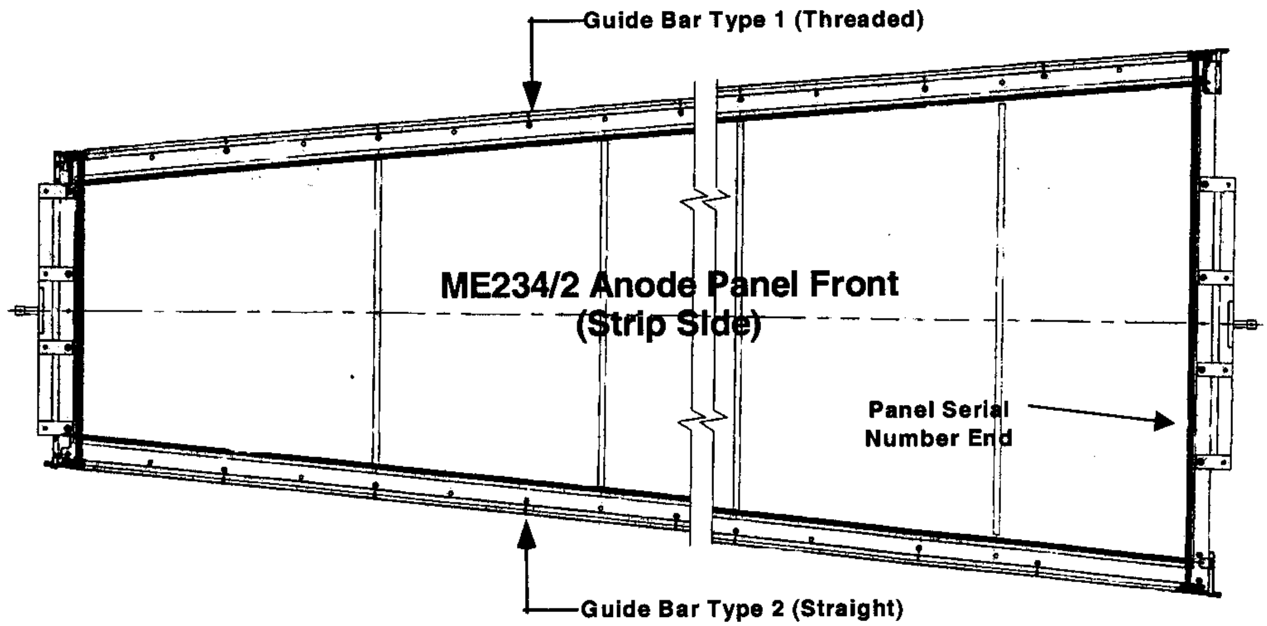
4.4 Install the Wire Guide Bar Type 2 (Straight) and tooling onto the panel per dwg MD-368950. **Do not tighten** any of the screws holding the Wire Guide on the panel side through the Insert (part # 368867).

Note(s):

When installing the Wire Guides, ensure that that the Guide Bar Type 1 (Threaded) is located on the edge near the serial number.

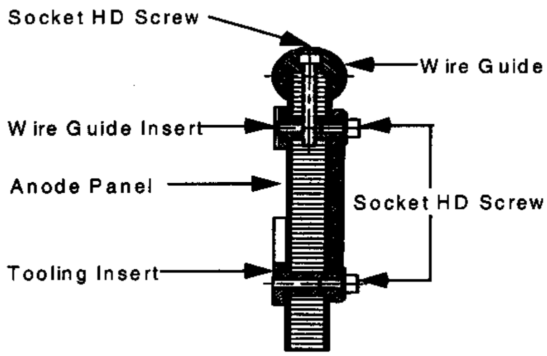
4.5 Install the Wire Guide Type 1 (Threaded Bar) and tooling onto the panel as following per dwg MD-368950. **Do not tighten** any of the screws holding the Wire Guide on the panel side through the Insert (part # 368867).

Top View of Panel



Completed

4.6 During the installation of part # 368867, make holes through the panel honeycomb in the 7 locations along a Wire Guides where parts 368867 will be mounted. ☑



Typical Wire Guide Installation onto Panel
Wide End Shown

Guide Bar Part Number	Description	Qty
MA-368959	Guide Bar Type 1 (Threaded)	1 ea
MA-368961	Guide Bar Type 2 (Straight)	1 ea
MA-368867	Insert	8 ea
N/A	8-32 X 1.5 Socket HD Screw	12 ea
Blank		
Blank		

4.7 Record in the box below, which set of Wire Guide Bars is used.

white

Helen Jensen
Technician(s)

7/16/01
Date

5.0 Wire Guides Alignment Procedure

Completed

5.1 Use 5 strands of 50μm line approximately 6 feet (2 meters) long with a small weight at the both ends and place them on the pad with the cross mark (typically the 3rd pad) on the wire fixation bars (pad closest to the narrow side of the chamber). Adjust the position of the Wire Guides using the10-24 screw in assemblies 368812 to locate the 5 wires approximately in the center of the appropriate pads. Ideally the wire must fall on the center of the pad. Variations of +/- 30 mils are acceptable.

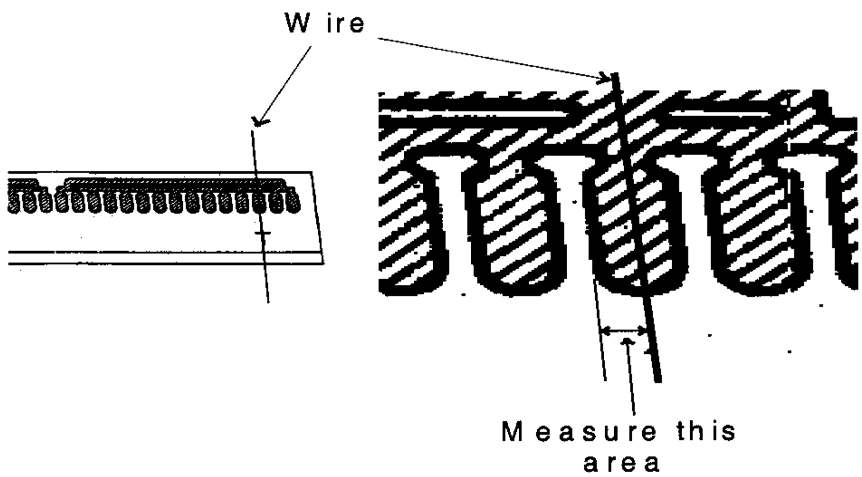
5.2 Tighten up all the screws locating the Wire Guides.

5.3 Rotate the panel on the panel cart. PERFORM ONLY A CHECK that the wires are centered on the first and last pads of each wire fixation bar on the other side. If Wire Guides need to be moved at this time, a new compromise with the first side needs to be found.

5.4 With an eyepiece, measure and record the distances from the wires to the edges of the pads, performing the measurement like shown in the figure below.

Note(s):

Always take the measurement closer to the wide end of the panel.



Strip Side	Straight Wire Guide Side	Threaded Wire Guide Side
Wire Bar 1 (Narrow End)	.40	.35
Wire Bar 2	.35	.35
Wire Bar 3	.35	.35
Wire Bar 4	.35	.30
Wire Bar 5 (Wide End)	.46	.40

Non-Strip Side	Straight Wire Guide Side	Threaded Wire Guide Side
Wire Bar 1 (Narrow End)	.40	.40
Wire Bar 2	.40	.35
Wire Bar 3	.40	.30
Wire Bar 4	.40	.35
Wire Bar 5 (Wide End)	.45	.40

Helen Jensen
Technician(s)

7/16/01
Date

6.0 200 µm Wire Installation

Completed

6.1 Place the panel on the assembly table; panel strip side facing up. ☑

6.2 Acquire the 200 µm gold plated Cu-Be wire (dwg 368047). Record the Lot # below. ☑

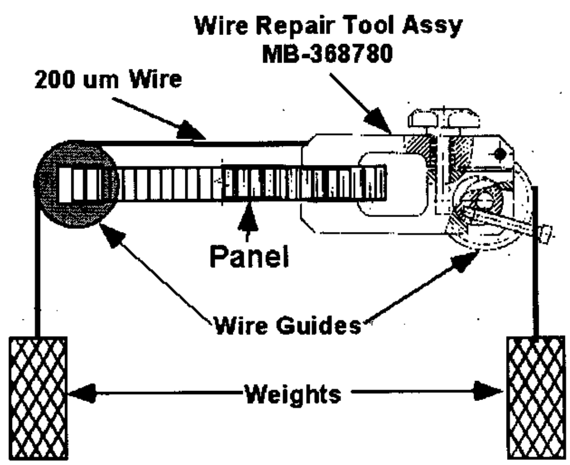
Lot No#	spool #3

6.3 Handling the wire with White (Lint Free) Gloves, cut 1 piece approximately 150 cm (6 feet) long. Secure the ends of the wire to two 500 grams weights. ☑

6.4 Clean the wire with Ethyl Alcohol (Fermi Stk. No. 1920-0600) and a low-lint wipe (Fermi Stk. No. 1660-2500). ☑

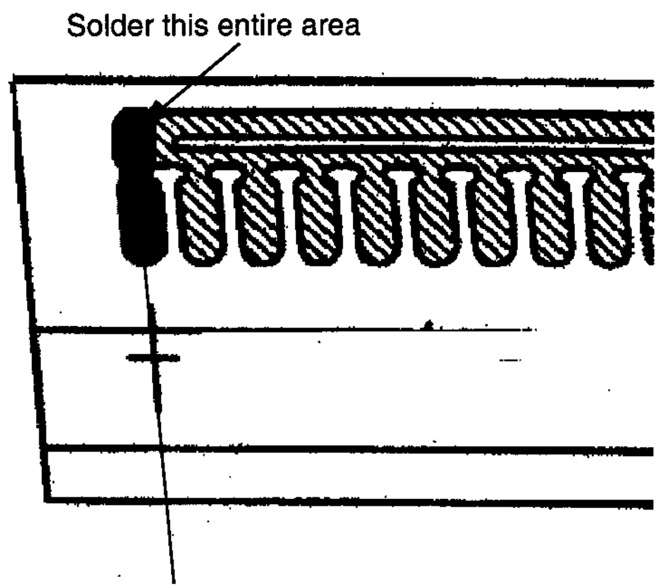
6.5 Locate the wire on the wire fixation bars. Make sure the wire is located close to the cross-mark on the wire fixation bar. A variation of +/- 30 mils is acceptable. ☑

6.6 Allow one of the two weights to hang off the panel at a 45-degree angle through a pulley. ☑



Completed

6.7 Solder the 200 μm wire to the wire fixation bar using Almit Solder (MA-368291) ☑
Use the complete length of the pad to apply the solder according to dwg below.



Note(s):

Ensure the solder joint surface is smooth to the touch and shiny.

6.8 Break off the wire and remove the weight. ☑

D. Eddy H. Jensen
Technician(s)

7-16-01
Date

Completed ☑

6.9 Clean the soldering pad that has the 200μm wire attached with Ethyl Alcohol (Fermi Stk. No. 1920-0600) and low lint wipes (Fermi Stk. No. 1660-2500) to remove flux and any other dusts, dirt, oils, or foreign material.

Note(s):
Ensure all used alcohol wipes are disposed of in the Red Safety Can as Special Waste.

6.10 Repeat steps 6.3 through 6.10 until a total of ten (10) wires are soldered on and as each wire is completed check it off in the box below

Indicate side: Strip ☑ Non-Strip ☐

Wire Number	Completed
1	✓
2	
3	
4	
5	
6	
7	
8	
9	
10	

6.11 Rotate the panel on the Soldering table and perform Steps 6.3 through 6.10.

Indicate side: Strip ☐ Non-Strip ☑

Wire Number	Completed
1	✓
2	
3	
4	
5	
6	
7	
8	
9	
10	

D. Eddy Hoffman
Technician(s)

7-16-01
Date

7.0 Panel Wire Winding Set-Up

Completed

Note(s):

The following checks are performed with no wire mounted on the winding machine.

7.1 Plug in the electrical line cord. ☑

7.2 House air should be connected at all times, and set the Wire Winding Machine tension gauge to 260 GRAMS. ☑

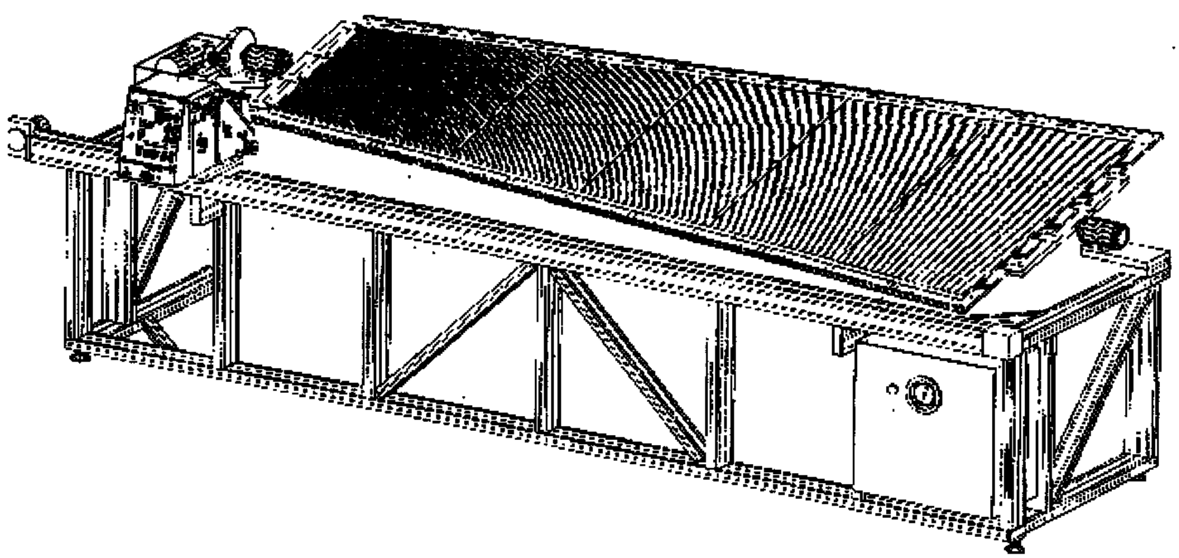
7.3 Ensure the panel is mounted with the narrow end close to the panel driving motor, the threaded comb on top and the strip side facing the operator (or indexing head) ☑

7.4 Ensure the panel is supported properly on the turning mechanism and the panel support tooling is fully engaged into the turning mechanism. ☑

7.5 Clean the entire panel with Ethyl Alcohol (Fermi Stk. No. #1920-060000) and Texwipe TX325 (3" X 2.5") Natural Wipes (McMaster-Carr) to remove any dirt, dusts, oils, and other foreign material on the panel. ☑

7.6 Ensure all equipment is removed from the area in which the panel will rotate. ☑

7.7 Turn on the Wire Winding Tensioner. Refer to Panel Wire Winding Machine OP-368900. ☑



Completed ✓

7.8 Bring the winding head past the left edge of the tape marker located winding head guide. Reverse the direction of motion on the dispensing head. Set the head velocity to 1. Set the indexer to Run. ☑

7.9 Down-load in the machine controller the appropriate number of indexing counts through the following procedure:

7.9.1 Open the panel housing the machine controls ☑

7.9.2 Toggle the switch to the position needed for the panel under winding (up for 10-degree chamber, down for 20 degree chamber). ☑

7.9.3 Push the red downloading button once. ☑

7.9.4 Toggle the switch back to the neutral position. ☑

7.9.5 Close and secure the panel housing the machine controls. ☑

7.10 Turn on the glass scale read-out and zero it. Start the panel for 10-15 rotations at 50% of speed checking the following items: ☑

7.10.1 Wire Dispensing head indexing on the threaded comb. ☑

7.10.2 Indexing amount, as displayed by the glass scale, corresponding to 124.47 mils for a 10 degree chamber and to 122.81 mils for a 20 degree chamber. The best way to perform these measurements is to read the indexing amount over 10 steps, to achieve a reading of 1.2447 inches and 1.2281 inches respectively. Record the read-out. ☑

Indexing on Threaded Comb	124.470
First 10 Step Average Index	1.2447

7.11 In case the head indexes by an amount different than 124.45 mils on the first step, stop and reverse the panel rotation, go back to the starting position (left edge of the tape marker) and restart. ☑

7.12 Stop the panel rotation and reverse it until the indexing head is to the right edge of the tape marker. Bring the panel in the vertical position, with the threaded comb on top and the strip facing the operator. ☑

Technician(s): L White   Date: 7/16/01

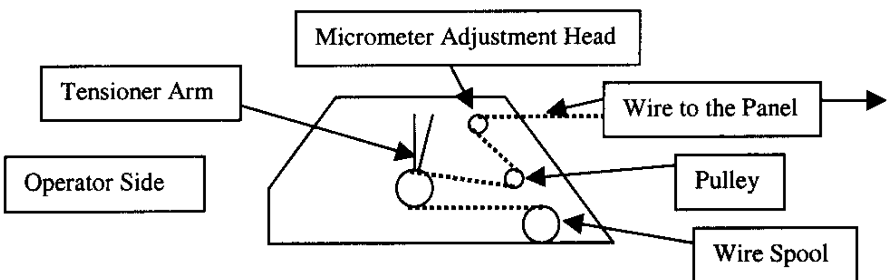
8.0 Panel Wire Winding

Completed

8.1 Acquire the proper gold plated tungsten wire (MA-369019) required to wire wind this panel and record the appropriate information below. ☑

Lot No#	50/EG44-410
Spool Footage	21000
Wire Size	50
Spool Weight	133.5
Date of Mfg	09/00

8.2 Ensure the head is located at the start point, and install the wire spool (MA-368019) onto the wire winding spool tensioner and spool the wire through the tensioner. ☑



Side View of Control Console for Wire Winding Machine

8.3 Set the Micro Adjustment Head to its starting point (.001). ☑

8.4 Zero the Glass Scale read-out. ☑

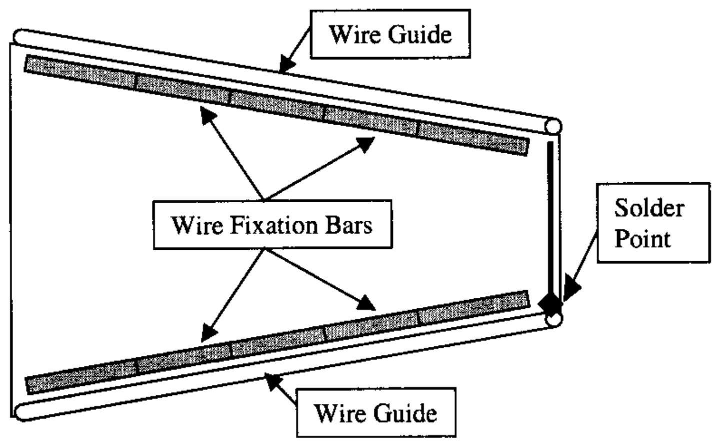
K White
Technician(s)

7/16/01
Date

Completed

8.5 After spooling through the wire tensioner, tape the end of the wire to the panel. Turn ON tension and start winding the panel 10 full turns without indexing to allow the wire to overlap.

8.5.1 Solder the group of 10 wires together at the bottom edge of one side of the panel between the comb and the Wire Fixation Bar.



8.5.2 Rotate the panel 180° and solder the group of 10 wires at the bottom edge of the other side of the panel between the comb and the Wire Fixation Bar.

Note(s):

When soldering the wires together, <u>DO NOT SOLDER</u> to the solder pad on the wire fixation bar.

B White
Technician(s)

7/16/01
Date

Completed

8.6 Panel Winding

Note(s):

Beware of all moving parts when winding the panel.

Ensure that there is nothing in the area of the rotation path of the panel before engaging.

8.6.1 Begin actual wire winding and visually check to ensure the placement of the wire into the slots on the Wire Guides. Record panel wire winding start date and start time below. ☑

	Date	Time
Panel Start	7/16/01	9.00

8.6.2 When the wire has been wound to complete the first full turn, CHECK to ensure the wire is centered on both sides of the panel on the first pad. ☑

8.6.3 Make one or two complete turns, STOP and re-check to ensure the wire is centered on the solder strip pad. During the balance of the panel winding, visually check to ensure the wire is being wound on center of the solder pads. If not adjust the wire placement by adjusting the micrometer mounted on the Winding Machine Head. ☑

8.6.4 During the first winds, when the Wire Guide engages the wires, check that the wire gets to the center of the Wire Guide groove. If necessary adjust the position of the wire through the micrometer mounted on the Winding Machine Head. ☑

8.7 Record the Paddle Rate from the Wire Console Panel in the below box.

Note(s):

The maximum allowed paddle rate is 65%.

Paddle Rate	65%

8.8 During the course of winding the panel, if a wire breaks, stop the machine and solder the wire on to the 3rd from the last pad of the previous segment (Wire Fixation Bar). Follow the procedure from Steps 8.5, 8.5.1 and 8.5.2 and then continue to wind the panel. In the chart below, record which segment the wire broke in.

Break	Segment

8.9 During the course of winding the panel, if a change of wire spool is required, record the following information from the spool below. Note in Step 8.11 panel diagram, with a designation of 'C' and an appropriate sequence number (i.e., C1 is first wire change) where a wire spool change occurred.

	Spool Change #2	Spool Change #3
Lot No#		
Spool Footage		
Wire Size		
Date of Mfg		

B White
Technician(s)

7/16/01
Date

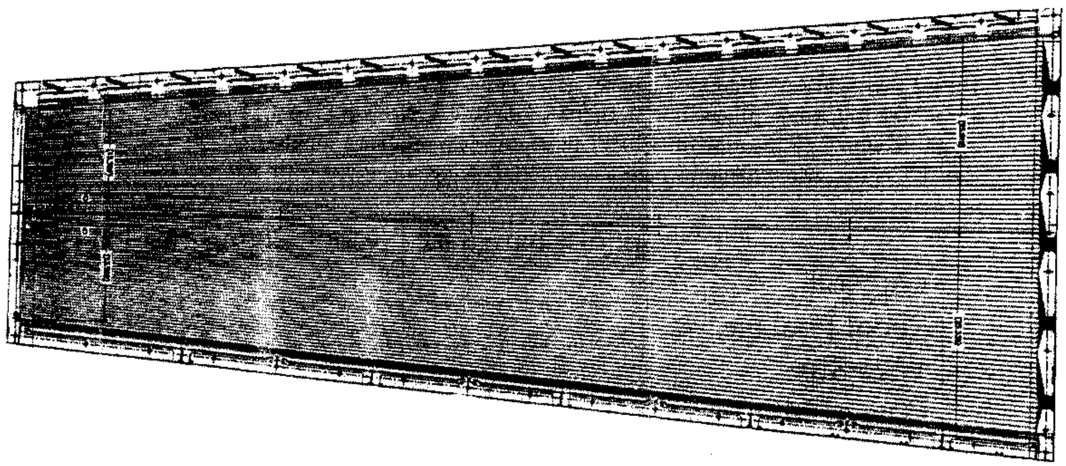
Completed

8.10 During the course of the winding of the panel, record below the areas where wire 'skips' occurred by numbers and number of 'back-tracking' turns required to access an adequate starting point. Indicate in red ink on the drawing below any place where a skip occurred. Use the designation of 'S' for skips (i.e., S1 is for Skip #1). ☐

8.11 During the course of the winding of the panel, record below the areas where wire 'doubles' occurred by numbers and number of 'back-tracking' turns required to access an adequate starting point. Indicate in red ink on the drawing below any place where a double wire occurred. Use the designation of 'D' for doubles (i.e., D1 is for Double #1). ☐

Note(s):

When a Skip/Double occurs, 'back-track' by 10 complete turns before starting the winding again.



SKIPS	'Back-Tracking Turns
Skip #1	N/A
Skip #2	
Skip #3	
Skip #4	
Skip #5	

Double	'Back-Tracking Turns
Double #1	N/A
Double #2	
Double #3	
Double #4	
Double #5	

Completed

Note(s):

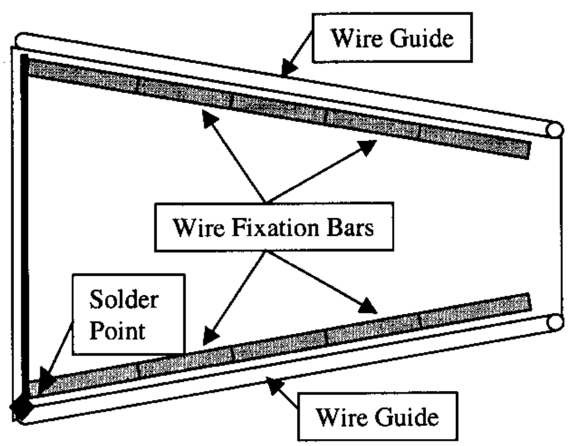
DO NOT touch the wire after winding is complete!

8.12 After completing the full wire winding on the panel, continue wire winding past the ends of the wire fixation bars a minimum of 2 full turns. ☑

8.13 Turn OFF indexing and continue wire wrapping while overlapping the wire a minimum of 10 full turns. ☑

8.14 After wire winding visually check for double wires and skipped wires. ☑

8.15 Solder the group of 10 wires together at the bottom edge of one side of the panel between the comb and the Wire Fixation Bar. ☑



8.16 Rotate the panel 180° and solder the group of 10 wires at the bottom edge of the other side of the panel between the comb and the Wire Fixation Bar. ☐

Note(s):

When soldering the wires together, <u>DO NOT SOLDER</u> to the solder pad on the wire fixation bar.

Technician(s) ____________ Date 7-16-01

Completed

8.17 Secure the wire to the panel using masking tape. Shut off the wire tensioner, cut the wire and properly secure the wire end to the spool ☑

8.18 Remove the Wire Spool from the Wire Winding Machine and place the perform the below.

8.18.1 Acquire a zip-lock storage bag and affix the Wire Spool label as shown below, onto the bag. ☑

8.18.2 Weigh the spool and record the spool weight below and on the Wire Spool label. ☑

8.18.3 Record the wire spool lot #, date and technician initials on the Wire Spool label and below. ☑

ME234/2-A-XXX	
Lot #	9/E744-014
Weight	
Tech/Date	SW, 7/16/01

8.18.4 Place the Wire Spool into the zip-lock storage bag and store properly. ☑

Technician(s) ______ Date 7-17/01

8.19 Record panel wire winding finish date and finish time below.

	Date	Time
Panel Finish	7-16 01	12:30

8.20 Record the Glass-scale readout

Glass scale Readout	128326

Technician(s) ______ Date 7/17/01

9.0 Production Complete

XXX 9.1 Process Engineering verify that the CMS Anode Panel Wire Winding (5520-TR-333365) is accurate and complete. This shall include a review of all steps to ensure that all operations have been completed and signed off. Ensure that all Discrepancy Reports, Nonconformance Reports, Repair/Rework Forms, Deviation Index and dispositions have been reviewed by the Responsible Authority for conformance before being approved.

Comments:

Pamela Behan
Process Engineering/Designee

7/31/01
Date

10.0 Attach the Process Engineering "OK to Proceed" Tag on the panel.

N/A
Process Engineering/Designee

Date

11.0 Proceed to the next major assembly operation as required.

Fermi National Accelerator Laboratory
Batavia, IL 60510

CMS ME234/2 ANODE PANEL WIRE WINDING TRAVELER

Reference Drawing(s)

Endcap Muon Chamber ME234/2 Anode Panel Assy 5220-ME-368221

Magnet/Device Series: ME234/2	
Budget Code:	Project Code:
Released by: Pamela Dixon	Date: NOV 02 2001
Date Closed: 11/20/01	Scan Pages: 21
Prepared by: B. Jensen, M. Hubbard, L. Lee, P. Isham	

Title	Signature	Date
TD / E&F Process Engineering	Bob Jensen Bob Jensen/Designee	10/24/01
TD / E&F CMS Assembly	Glenn Smith Glenn Smith/Designee	10/25/01
TD / E&F Technological Physicist	Oleg Prokofiev/Designee	10/25/01
TD / E&F CMS Project Manager	Apollinari Giorgio Giorgio Apollinari/Designee	10/26/01

Revision Page

Revision	Step No.	Revision Description	TRR No.	Date
None	N/A	Initial Release	N/A	02/08/00
A		Changed the arrow for "Panel Serial Number End" on drawing on page 7.	0967	05/31/00
	6.4	Moved step 6.8 to 6.4		
	7.2	Changed Gauge setting from 250g to 260 g.		
	8.4	Added steps 8.4.1, 8.4.2 and added new drawing.		
	8.9	Added step 8.9.		
	8.11,8.12	Added steps 8.11 and 8.12 and added new drawing.		
B	4.7	Added step 4.7 and info box.	1012	07/24/00
	8.8	Added step for broken wire procedure and chart.		
	8.9	Changed 'information on the' to 'information from the'		
	8.9	Changed 'in Step 5.6' to 'in Step 8.11 panel diagram'		
	8.10,8.11	Reworded steps for clarification, and changed "Break" to "Double" in chart.		
	8.16	Rewrote step to ensure proper wire spool marking.		
C	4.2	Removed signature line.	1061	09/28/00
	6.2	Adjusted info box to reflect procedure used on the Production Floor.		
	6.10	Added side designation check boxes and Wire #'s.		
	6.11	Added side designation check boxes and Wire #'s.		
D	8.14	Added step to visually inspect wires after wire winding is done.	1108	01/15/01
E	8.5	Changed from turn on panel rotation to turn on tension	1140	4/2/01
F	CVRPG	Added magnet device, date closed, scanned pages to the cover sheet, and serial number prefix to the bottom of the cover sheet.	1263	10/24/01
	2.1	Change step 2.1 to refer to specification # 333361.		
	4.1,4.2	Remove step 4.1 to 4.2.		
	4.3	Remove part list under step 4.3 and signature line and date.		
	5.0	Changed 5 strands and 5 wires to 2 strands and 2 wires.		
	8.1,8.4	Remove signature line and date from step 8.1,8.4.		
	10.0	Remove step 10.0 and signature line and date.		

Ensure appropriate memos and specific instructions are placed with the traveler before issuing the sub traveler binder to production.

1.0 General Notes

1.1 White (Lint Free) Gloves (Fermi stock 2250-1800) or Nitrile Gloves (Fermi stock 2250-2040) or equivalent shall be worn by all personnel, as required, when handling all product parts after the parts have been prepared/cleaned.

1.2 All steps that require a sign-off shall include the Technician/Inspectors first initial and full last name.

1.3 No erasures or white out will be permitted to any documentation. All incorrectly entered data shall be corrected by placing a single line through the error, initial and date the error before adding the correct data.

1.4 All Discrepancy Reports issued shall be recorded in the left margin next to the applicable step.

1.5 All personnel performing steps in this traveler must have documented training for this traveler and associated operating procedures.

1.6 Personnel shall perform all tasks in accordance with current applicable ES&H guidelines and those specified within the step.

1.7 Cover the panel/chamber, as required, with Mylar or approved material when not being serviced or assembled.

1.8 Never hand pass anything over a panel, damage could occur.

2.0 Parts Kit List

2.1 Refer to specification # 5520-TR-333361.

3.0 Panel Acquisition

Completed

3.1 Acquire the Anode (ME-368225) panel as per the serial number listed in the footer, right side of this traveler.

3.2 Visually check the panel for damage which is to include but not limited to scratches/gouges in the copper, damage to the sides and/or corners.

Helen
Technician(s)

11.08.2001
Date

4.0 Panel Tooling Installation

Completed

4.1 Install onto the panel the following Anode Panel Wire Winding Guide Tooling per dwg MD-368950.

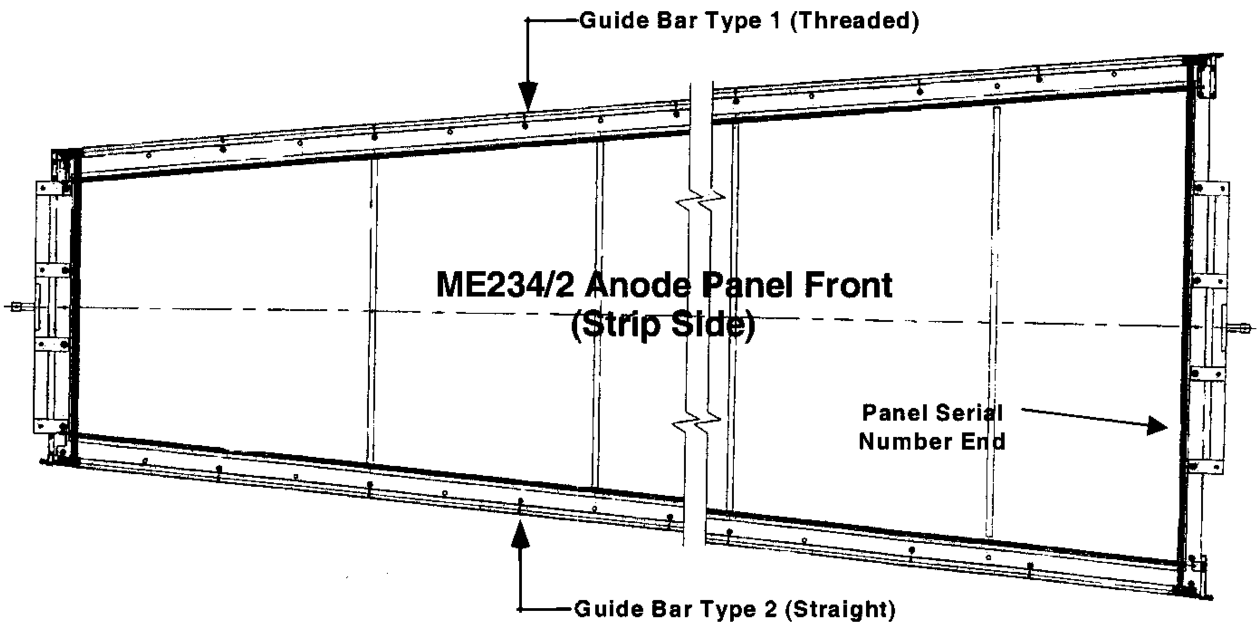
4.2 Install the Wire Guide Bar Type 2 (Straight) and tooling onto the panel per dwg MD-368950. **Do not tighten** any of the screws holding the Wire Guide on the panel side through the Insert (part # 368867).

Note(s):

When installing the Wire Guides, ensure that that the Guide Bar Type 1 (Threaded) is located on the edge near the serial number.

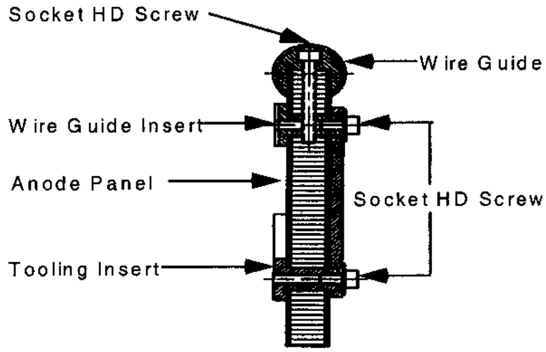
4.3 Install the Wire Guide Type 1 (Threaded Bar) and tooling onto the panel as following per dwg MD-368950. **Do not tighten** any of the screws holding the Wire Guide on the panel side through the Insert (part # 368867).

Top View of Panel



Completed

4.4 During the installation of part # 368867, make holes through the panel honeycomb in the 7 locations along a Wire Guides where parts 368867 will be mounted. ☑



Typical Wire Guide Installation onto Panel
Wide End Shown

Guide Bar Part Number	Description	Qty
MA-368959	Guide Bar Type 1 (Threaded)	1 ea
MA-368961	Guide Bar Type 2 (Straight)	1 ea
MA-368867	Insert	8 ea
N/A	8-32 X 1.5 Socket HD Screw	12 ea
Blank		
Blank		

4.5 Record in the box below, which set of Wire Guide Bars is used.

white combs

Helen / Sun
Technician(s)

11.08.2001
Date

5.0 Wire Guides Alignment Procedure

Completed

5.1 Use 2 strands of 50μm line approximately 6 feet (2 meters) long with a small weight at the both ends and place them on the pad with the cross mark (typically the 3rd pad) on the wire fixation bars (pad closest to the narrow side of the chamber). Adjust the position of the Wire Guides using the10-24 screw in assemblies 368812 to locate the 2 wires approximately in the center of the appropriate pads. Ideally the wire must fall on the center of the pad. Variations of +/- 30 mils are acceptable.

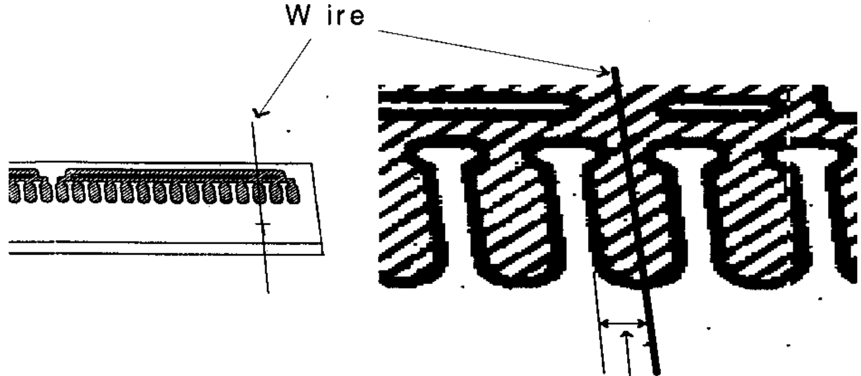
5.2 Tighten up all the screws locating the Wire Guides. 7

5.3 Rotate the panel on the panel cart. PERFORM ONLY A CHECK that the wires are centered on the first and last pads of each wire fixation bar on the other side. If Wire Guides need to be moved at this time, a new compromise with the first side needs to be found.

5.4 With an eyepiece, measure and record the distances from the wires to the edges of the pads, performing the measurement like shown in the figure below.

Note(s):

Always take the measurement closer to the wide end of the panel.



Strip Side	Straight Wire Guide Side	Threaded Wire Guide Side
Wire Bar 1 (Narrow End)	45 / 35	40 / 40
Wire Bar 2	40 / 40	20 / 60
Wire Bar 3	45 / 35	20 / 60
Wire Bar 4	45 / 35	20 / 60
Wire Bar 5 (Wide End)	35 / 45	50 / 30

Non-Strip Side	Straight Wire Guide Side	Threaded Wire Guide Side
Wire Bar 1 (Narrow End)	30 / 50	40 / 40
Wire Bar 2	30 / 50	65 / 15
Wire Bar 3	50 / 30	60 / 20
Wire Bar 4	25 / 55	60 / 20
Wire Bar 5 (Wide End)	25 / 55	45 / 35

Sun HS
Technician(s)

11.08.2001
Date

6.0 200 µm Wire Installation

Completed

6.1 Place the panel on the assembly table; panel strip side facing up. ☑

6.2 Acquire the 200 µm gold plated Cu-Be wire (dwg 368047). Record the Lot # below. ☑

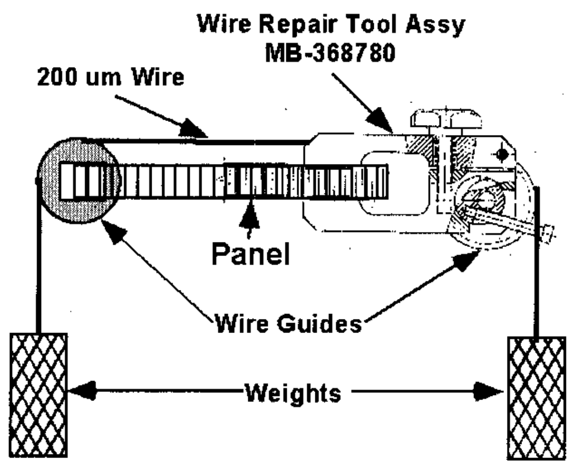
Lot No#	spool 4 #

6.3 Handling the wire with White (Lint Free) Gloves, cut 1 piece approximately 150 cm (6 feet) long. Secure the ends of the wire to two 500 grams weights. ☑

6.4 Clean the wire with Ethyl Alcohol (Fermi Stk. No. 1920-0600) and a low-lint wipe (Fermi Stk. No. 1660-2500). ☑

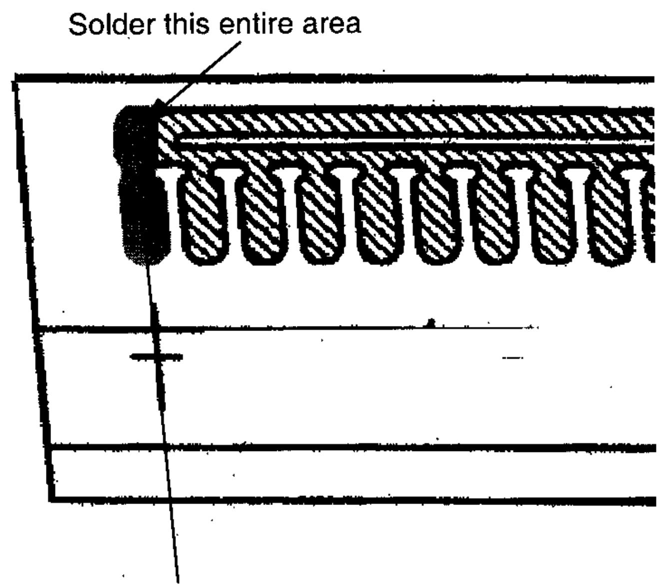
6.5 Locate the wire on the wire fixation bars. Make sure the wire is located close to the cross-mark on the wire fixation bar. A variation of +/- 30 mils is acceptable. ☑

6.6 Allow one of the two weights to hang off the panel at a 45-degree angle through a pulley. ☑



Completed

6.7 Solder the 200 μm wire to the wire fixation bar using Almit Solder (MA-368291)
Use the complete length of the pad to apply the solder according to dwg below.



Note(s):

Ensure the solder joint surface is smooth to the touch and shiny.

6.8 Break off the wire and remove the weight.

Helen / Sun
Technician(s)

11, 08, 2001
Date

Completed

6.9 Clean the soldering pad that has the 200μm wire attached with Ethyl Alcohol (Fermi Stk. No. 1920-0600) and low lint wipes (Fermi Stk. No. 1660-2500) to remove flux and any other dusts, dirt, oils, or foreign material. ☑

Note(s):

Ensure all used alcohol wipes are disposed of in the Red Safety Can as Special Waste.

6.10 Repeat steps 6.3 through 6.10 until a total of ten (10) wires are soldered on and as each wire is completed check it off in the box below

Indicate side: Strip ☑ Non-Strip ☐

Wire Number	Completed
1	✓
2	✓
3	✓
4	✓
5	✓
6	✓
7	✓
8	✓
9	✓
10	✓

6.11 Rotate the panel on the Soldering table and perform Steps 6.3 through 6.10.

Indicate side: Strip ☐ Non-Strip ☑

Wire Number	Completed
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

Helen / Sun
Technician(s)

11.08.2001
Date

7.0 Panel Wire Winding Set-Up

Completed

Note(s):

The following checks are performed with no wire mounted on the winding machine.

7.1 Plug in the electrical line cord.

7.2 House air should be connected at all times, and set the Wire Winding Machine tension gauge to 260 GRAMS.

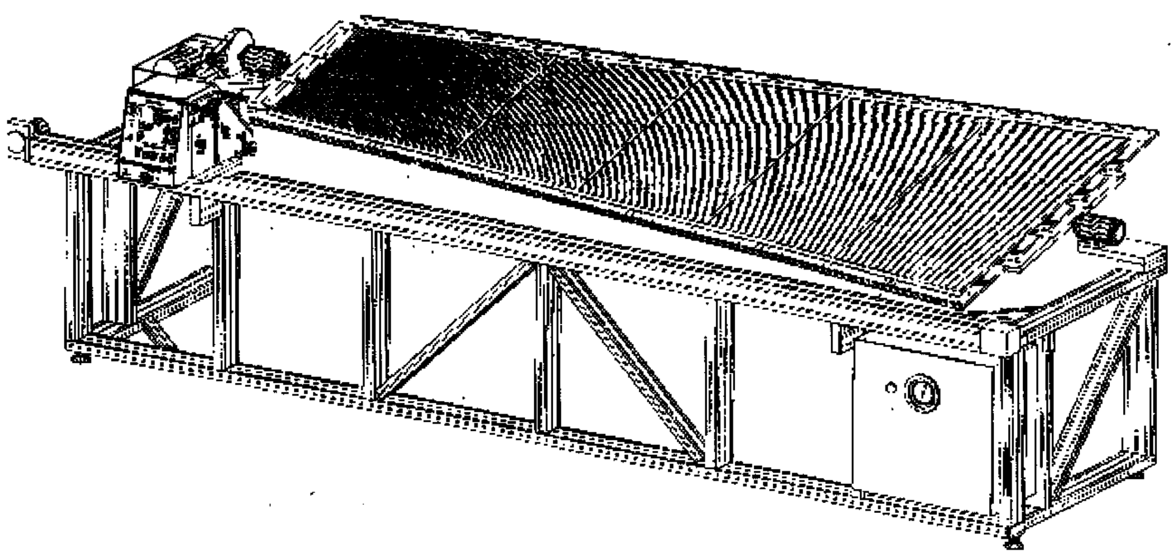
7.3 Ensure the panel is mounted with the narrow end close to the panel driving motor, the threaded comb on top and the strip side facing the operator (or indexing head)

7.4 Ensure the panel is supported properly on the turning mechanism and the panel support tooling is fully engaged into the turning mechanism.

7.5 Clean the entire panel with Ethyl Alcohol (Fermi Stk. No. #1920-060000) and Texwipe TX325 (3" X 2.5") Natural Wipes (McMaster-Carr) to remove any dirt, dusts, oils, and other foreign material on the panel.

7.6 Ensure all equipment is removed from the area in which the panel will rotate.

7.7 Turn on the Wire Winding Tensioner. Refer to Panel Wire Winding Machine OP-368900.



Completed

7.8 Bring the winding head past the left edge of the tape marker located winding head guide. Reverse the direction of motion on the dispensing head. Set the head velocity to 1. Set the indexer to Run.

7.9 Down-load in the machine controller the appropriate number of indexing counts through the following procedure:

7.9.1 Open the panel housing the machine controls

7.9.2 Toggle the switch to the position needed for the panel under winding (up for 10-degree chamber, down for 20 degree chamber).

7.9.3 Push the red downloading button once.

7.9.4 Toggle the switch back to the neutral position.

7.9.5 Close and secure the panel housing the machine controls.

7.10 Turn on the glass scale read-out and zero it. Start the panel for 10-15 rotations at 50% of speed checking the following items:

7.10.1 Wire Dispensing head indexing on the threaded comb.

7.10.2 Indexing amount, as displayed by the glass scale, corresponding to 124.47 mils for a 10-degree chamber and to 122.81 mils for a 20-degree chamber. The best way to perform these measurements is to read the indexing amount over 10 steps, to achieve a reading of 1.2447 inches and 1.2281 inches respectively. Record the read-out.

Indexing on Threaded Comb	YES
First 10 Step Average Index	1.24465

7.11 In case the head indexes by an amount different than 124.45 mils on the first step, stop and reverse the panel rotation, go back to the starting position (left edge of the tape marker) and restart.

7.12 Stop the panel rotation and reverse it until the indexing head is to the right edge of the tape marker. Bring the panel in the vertical position, with the threaded comb on top and the strip facing the operator.

Sun HS
Technician(s)

11, 08, 2001
Date

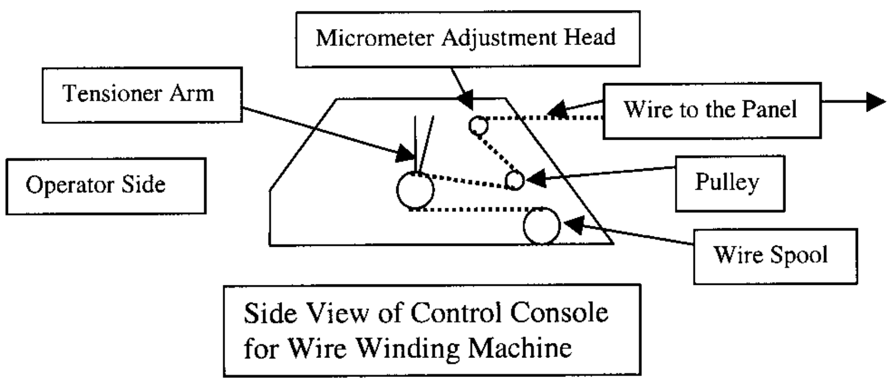
8.0 Panel Wire Winding

Completed

8.1 Acquire the proper gold plated tungsten wire (MA-369019) required to wire wind this panel and record the appropriate information below.

Lot No#	50/E9072_414
Spool Footage	2600
Wire Size	
Spool Weight	132,3 g
Date of Mfg	0105

8.2 Ensure the head is located at the start point, and install the wire spool (MA-368019) onto the wire winding spool tensioner and spool the wire through the tensioner.



Side View of Control Console for Wire Winding Machine

8.3 Set the Micro Adjustment Head to its starting point (.001).

8.4 Zero the Glass Scale read-out.

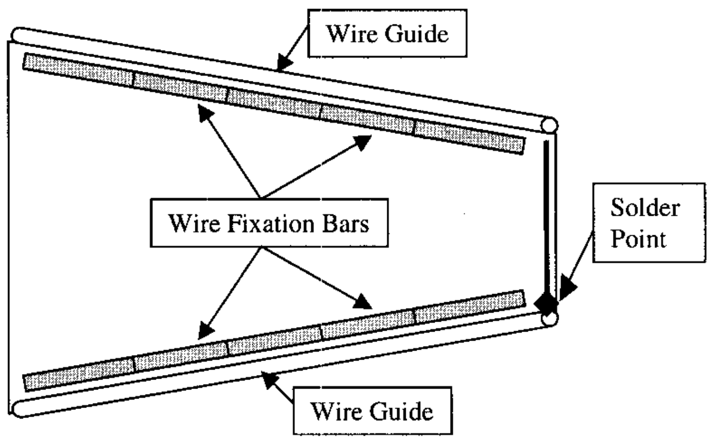
Sun HJ
Technician(s)

11,08,2001
Date

Completed

8.5 After spooling through the wire tensioner, tape the end of the wire to the panel. Turn ON tension and start winding the panel 10 full turns without indexing to allow the wire to overlap. ☑

8.5.1 Solder the group of 10 wires together at the bottom edge of one side of the panel between the comb and the Wire Fixation Bar. ☑



8.5.2 Rotate the panel 180° and solder the group of 10 wires at the bottom edge of the other side of the panel between the comb and the Wire Fixation Bar. ☑

Note(s):

When soldering the wires together, <u>DO NOT SOLDER</u> to the solder pad on the wire fixation bar.

Suh HS ____________ Technician(s)

11.08.2001 ____________ Date

Completed

8.6 Panel Winding

Note(s):

Beware of all moving parts when winding the panel.

Ensure that there is nothing in the area of the rotation path of the panel before engaging.

8.6.1 Begin actual wire winding and visually check to ensure the placement of the wire into the slots on the Wire Guides. Record panel wire winding start date and start time below.

	Date	Time
Panel Start	11.08.2001	9.47

8.6.2 When the wire has been wound to complete the first full turn, CHECK to ensure the wire is centered on both sides of the panel on the first pad.

8.6.3 Make one or two complete turns, STOP and re-check to ensure the wire is centered on the solder strip pad. During the balance of the panel winding, visually check to ensure the wire is being wound on center of the solder pads. If not adjust the wire placement by adjusting the micrometer mounted on the Winding Machine Head.

8.6.4 During the first winds, when the Wire Guide engages the wires, check that the wire gets to the center of the Wire Guide groove. If necessary adjust the position of the wire through the micrometer mounted on the Winding Machine Head.

8.7 Record the Paddle Rate from the Wire Console Panel in the below box.

Note(s):

The maximum allowed paddle rate is 65%.

Paddle Rate	65 %

8.8 During the course of winding the panel, if a wire breaks, stop the machine and solder the wire on to the 3rd from the last pad of the previous segment (Wire Fixation Bar). Follow the procedure from Steps 8.5, 8.5.1 and 8.5.2 and then continue to wind the panel. In the chart below, record which segment the wire broke in.

Break	Segment

8.9 During the course of winding the panel, if a change of wire spool is required, record the following information from the spool below. Note in Step 8.11 panel diagram, with a designation of 'C' and an appropriate sequence number (i.e., C1 is first wire change) where a wire spool change occurred.

	Spool Change #2	Spool Change #3
Lot No#		
Spool Footage		
Wire Size		
Date of Mfg		

Technician(s): Sun HS

Date: 11, 08, 2001

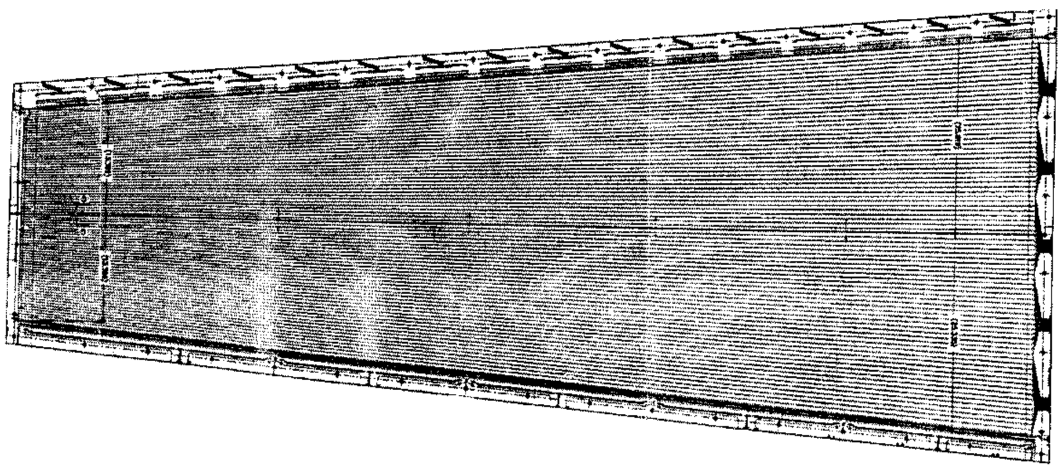
Completed

8.10 During the course of the winding of the panel, record below the areas where wire 'skips' occurred by numbers and number of 'back-tracking' turns required to access an adequate starting point. Indicate in red ink on the drawing below any place where a skip occurred. Use the designation of 'S' for skips (i.e., S1 is for Skip #1).

8.11 During the course of the winding of the panel, record below the areas where wire 'doubles' occurred by numbers and number of 'back-tracking' turns required to access an adequate starting point. Indicate in red ink on the drawing below any place where a double wire occurred. Use the designation of 'D' for doubles (i.e., D1 is for Double #1).

Note(s):

When a Skip/Double occurs, 'back-track' by 10 complete turns before starting the winding again.



SKIPS	'Back-Tracking Turns
Skip #1	
Skip #2	
Skip #3	
Skip #4	
Skip #5	

Double	'Back-Tracking Turns
Double #1	
Double #2	
Double #3	
Double #4	
Double #5	

Completed

Note(s):

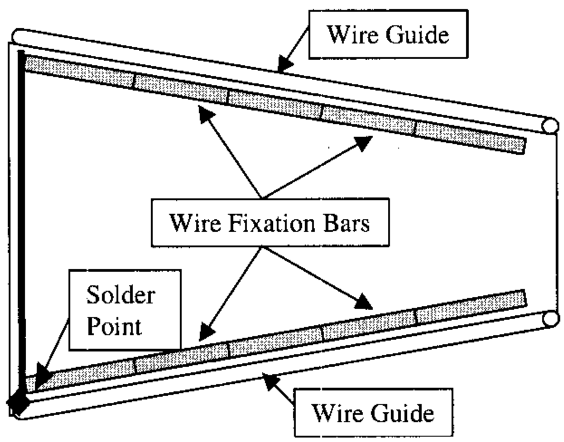
DO NOT touch the wire after winding is complete!

8.12 After completing the full wire winding on the panel, continue wire winding past the ends of the wire fixation bars a minimum of 2 full turns.

8.13 Turn OFF indexing and continue wire wrapping while overlapping the wire a minimum of 10 full turns.

8.14 After wire winding visually check for double wires and skipped wires.

8.15 Solder the group of 10 wires together at the bottom edge of one side of the panel between the comb and the Wire Fixation Bar.



8.16 Rotate the panel 180° and solder the group of 10 wires at the bottom edge of the other side of the panel between the comb and the Wire Fixation Bar.

Note(s):

When soldering the wires together, <u>DO NOT SOLDER</u> to the solder pad on the wire fixation bar.

Sun HS
Technician(s)

11, 08, 2001
Date

Completed

8.17 Secure the wire to the panel using masking tape. Shut off the wire tensioner, cut the wire and properly secure the wire end to the spool

8.18 Remove the Wire Spool from the Wire Winding Machine and place the perform below.

8.18.1 Acquire a zip-lock storage bag and affix the Wire Spool label as shown below, onto the bag.

8.18.2 Weigh the spool and record the spool weight below and on the Wire Spool label.

8.18.3 Record the wire spool lot #, date and technician initials on the Wire Spool label and below.

ME234/2-A-XXX	
Lot #	JO/E9072_u14
Weight	38.87
Tech/Date	Sun 11.08.2001

8.18.4 Place the Wire Spool into the zip-lock storage bag and store properly.

8.19 Record panel wire winding finish date and finish time below.

	Date	Time
Panel Finish	11,08,2001	12:51

8.20 Record the Glass-scale readout

Glass scale Readout	128,45155

Sun HC
Technician(s)

11,08,2001
Date

9.0 Production Complete

XXX 9.1 Process Engineering verify that the CMS Anode Panel Wire Winding (5520-TR-333365) is accurate and complete. This shall include a review of all steps to ensure that all operations have been completed and signed off. Ensure that all Discrepancy Reports, Nonconformance Reports, Repair/Rework Forms, Deviation Index and dispositions have been reviewed by the Responsible Authority for conformance before being approved.

Comments:

____
____
____
____
____
____
____
____
____
____

Pamela Ehon ____________ 11/20/01 ____________
Process Engineering/Designee Date

10.0 Proceed to the next major assembly operation as required.

Fermi National Accelerator Laboratory
Batavia, IL 60510

CMS ME234/2 MUON CHAMBER ASSEMBLY TRAVELER

Reference Drawing(s)

Endcap Muon Chamber ME234/2 Final Assembly
5520-ME-368220

Endcap Muon Chamber ME234/2 Frame Assembly
5520-ME-368229

Budget Code:	**Project Code:**
Released by: Pamela Brown	**Date:** JUL 0 2 2001
Prepared by: B. Jensen, M. Hubbard, L. Lee, P. Isham	

Title	Signature	Date
TD / E&F Process Engineering	Bob Jensen Bob Jensen/Designee	6/27/01
TD / E&F CMS Assembly	Glenn Smith Glenn Smith/Designee	06-27-01
TD / E&F Technological Physicist	[illegible] Oleg Prokofiev/Designee	06/27/01
TD / E&F CMS Project Manager	Apollinari Giorgio Giorgio Apollinari/Designee	06/27/01

Revision Page

Revision	Step No.	Revision Description	TRR No.	Date
None	N/A	Initial Release	N/A	6/20/00
A	5.7	Added Step 5.7	0990	7/07/00
	8.6, 8.7	Added Steps 8.6 and 8.7		
	12.22	Added Step 12.22 and drawing		
B	---	Removed the step measuring the thickness of the Chamber with the frame.	1069	10/09/00
	6.0	Added Section 6.0, "Chamber Cathode Strip Resistance Test."		
	7.0	Added Section 7.0,"Chamber Anode Wire Group Capacitance Measurements."		
	8.2.1	Added Part Numbers for Pneumatic Dispenser, Dispensing Cartridge, Mixing Nozzle, and Dispensing Needle.		
	13.12	Corrected the torque spec for the Alignment Pin Jam Nuts.		
C	4.6,4.13	Removed Lead Person signature line.	1084	11/28/00
	4.19,4.25	Removed Lead Person signature line.		
	4.31,4.37	Removed Lead Person signature line.		
	4.41	Removed Lead Person signature line.		
	5.11	Moved the installation of the LEMO Connectors from Step 11.1		
	5.17,5.26	Changed the torque value to 25 inch pounds.		
	6.2	Added a new step and drawing.		
	6.3	Added 51-Ohm Resistor Test.		
	7.1-7.4	Added Range Low-High values.		
	8.0	Added the Chamber High Voltage Test in Air.		
D	7.4	Changed the range on protection board #8 to 200/220, for channel number 16.	1114	02/06/01
	14.5	Added step 14.5		
E	7.1	Remove the protection board chart	1131	3/6/01
	7.2-7.4	Remove sections 7.2-7.4 "chamber anode wire group capacitance measurement"		
	7.1.1-7.1.8	Added protection board measure "PASS or FAIL"		
	7.2	Added attach chamber anode wire group capacitance measurement report to traveler		
	7.2.1	Added record number of pages in report		
F	14.22	Added connect AFEB Alignment Gages to Anode Side Panel, and a diagram and a chart.	1142	4/4/01
	10.16, 10.18	Added log pressure and flow rate at 1, 2, and 3 inches twice at intervals of 10 min.		
	10.17 10.19	Added new pressure of 2 and 3 inches is achieved.		
	10.20	Added log pressure and flow rate at 3 inches twice at intervals of 10 min. and line 6 to the chart.		
	10.21	Added 3 inches of pressure.		
G	14.0	Added 14.0 HV cable assembly	1146	4/24/01

Revision Page

Revision	Step No.	Revision Description	TRR No.	Date
H	4.11	Added alignment pins installation and removal.	1173	5/30/01
	4.12	Remove step 4.12.		
	4.16,4.28 4.35,4.40	Added temporary spacers and removal of alignment pins.		
	4.23	Changed alignment pins to temporary spacers.		
	4.24	Added remove alignment pins.		
	10.14-10.24	Changed and Added to leak test.		
	14.12	Added step 14.12.		
	17.0	Removed step and signature line.		
I	10.20	Added to notes to proceed to step 11.0 if leak test passed	1190	6/27/01
	11.1-11.3	Removed steps 11.1-11.3		
	11.4-11.7	Moved steps 11.4 -11.7 to 10.23		
	11.8	Removed step 11.8		
	15.19, 15.22	Removed steps 15.19 and 15.22		
	7.1	Removed "(LCR Meter)"		

Ensure appropriate memos and specific instructions are placed with the traveler before issuing the sub traveler binder to production.

1.0 <u>General Notes</u>

1.1 White (Lint Free) Gloves (Fermi stock 2250-1800) or Nitrile Gloves (Fermi stock 2250-2040) shall be worn by all personnel when handling all product parts after the parts have been prepared/cleaned.

1.2 All steps that require a sign-off shall include the Technician/Inspectors first initial and full last name.

1.3 No erasures or white out will be permitted to any documentation. All incorrectly entered data shall be corrected by placing a single line through the error, initial and date the error before adding the correct data.

1.4 All Discrepancy Reports issued shall be recorded in the left margin next to the applicable step.

1.5 All personnel performing steps in this traveler must have documented training for this traveler and associated operating procedures.

1.6 Personnel shall perform all tasks in accordance with current applicable ES&H guidelines and those specified within the step.

1.7 Cover the product/assembly with Mylar when not being serviced or assembled.

2.0 <u>Parts Kit List</u>

2.1 Attach the completed Parts Kit for this production operation to this traveler. Ensure that the serial number on the Parts Kit matches the serial number of this traveler. Verify that the Parts Kit received is complete.

Pamela Tohan
Process Engineering/Designee

JUL 02 2001
Date

3.0 Panel Selection

Completed

3.1 Select the required panels and ensure there are the correct quantity of each according to the chart below. ☑

Panel Location	Panel Designation	
Cathode Upper	ME234/2-UC-	095
Anode	ME234/2-A-	299
Cathode Inner	ME234/2-IC-	209
Anode	ME234/2-A-	297
Cathode Inner	ME234/2-IC-	208
Anode	ME234/2-A-	307
Cathode Lower	ME234/2-LC-	102

Technician(s) Darren Thom

Date 3 Aug. 2001

4.0 Panel Stacking/Assembly

4.1 Clean the Chamber Assembly Table with Ethyl Alcohol (Fermi Stk. No. #1920-0600) and a low lint wipe (Fermi Stk No. 1660-2500) to ensure the table is free of dirt, dust, oil and debris. ☑

4.2 Count out and clean EXACTLY 284 O-rings (368020) and place them in the Assembly Clean Room prior to stack up of panels. ☑

4.3 Clean the Cathode Lower Panel (both sides) with Ethyl Alcohol (Fermi Stk. No. #1920-0600) and a low lint wipe (Fermi Stk No. 1660-2500) and stage it onto the Chamber Assembly Table. ☑

4.4 Blow the Cathode Lower Panel off with Ionized air. ☑

4.5 Install and verify that all the O-rings (368020) are seated flat into their respective counterbores. ☑

4.6 Record the Serial number of the Lower Cathode Panel onto the chart after step 4.42. ☑

Technician(s) Darren Thom

Date 3 Aug. 2001

Completed ☑

4.7 Acquire the first Anode Panel and transport it to the Ionization Cleaning Station. Install Spacer Bars (368248) onto each side of the panel before performing the Air Knife procedure. ☑

4.8 Clean the first Anode Panel according to the Air Knife Operating Procedure. ☑

4.9 Inspect each hole and crevice to be sure it is clean and there is no debris, oil, dirt or particles and ensure the wires are free from any debris. ☑

4.10 Transport the first Anode Panel from the Ionization Cleaning station to the Chamber Assembly Table. Remove the Anode Panel from the transport cart and using temporary spacers between the panels to allow room for removal of the cart hardware, install the Anode Panel on top of the Cathode Lower Panel with the screw head of the cart hardware facing up and the Strip Side of the panel facing down. ☑

Note(s):

Ensure the O-rings remain in place as the Anode Panel is lowered over the Cathode Panel.

4.11 Remove the transport cart hardware. Install the two temporary 12" long alignment pins into the alignments holes, and then remove the temporary spacers from the Lower Cathode Panel. Lower the Anode Panel onto the Lower Cathode Panel pushing it down flat onto the Cathode Panel Gap Bars. Remove the alignment pins from the alignment holes. ☑

4.12 Record the Serial number of the first Anode Panel onto the chart after step 4.42. ☑

James Thomas
Technician(s)

3 Aug 2001
Date

4.13 Clean the Strip Side of a Cathode Inner Panel with Ethyl Alcohol (Fermi Stk. No. #1920-0600)and a low lint wipe (Fermi Stk No. 1660-2500), and blow both it off with Ionized air. ☑

4.14 Install and verify that all the O-rings (368020) are seated flat into there respective counter bores on the Strip Side of the panel. ☑

4.15 Lower the Inner Cathode Panel with the Strip Side facing down, onto the temporary spacers over the Anode Panel on the assembly table. Ensuring all O-rings are present and in proper position. Install the temporary alignment pins into the alignment holes, and then remove the temporary spacers from the Anode Panel and lower Cathode Panel into place. Remove the alignment pins from the alignment holes. ☑

Note(s):

Ensure the alignment pins remain perpendicular to the Panels.

Completed

4.16 Clean the Non-Strip Side of the Cathode Inner Panel with Ethyl Alcohol (Fermi Stk. No. #1920-0600)and a low lint wipe (Fermi Stk No. 1660-2500), and blow both it off with Ionized air. ☑

4.17 Install and verify that all the O-rings (368020) are seated flat into there respective counter bores on the Non-Strip Side of the panel. ☑

4.18 Record the Serial number of the Inner Cathode Panel onto the chart after step 4.42. ☑

Darren O Thomas
Technician(s)

3 Aug. 2001
Date

4.19 Acquire the second Anode Panel and transport it to the Ionization Cleaning Station. Install Spacer Bars (368248) onto each side of the panel before performing the Air Knife procedure. ☑

4.20 Clean the second Anode Panel according to the Air Knife Operating Procedure. ☑

4.21 Inspect each hole and crevice to be sure it is clean and there is no debris, oil, dirt or particles and ensure the wires are free from any debris. ☑

4.22 Transport the second Anode Panel from the Ionization Cleaning station to the Chamber Assembly Table. Remove the Anode Panel from the transport cart and using temporary spacers between the second Anode Panel and the Inner Cathode Panel to allow room for removal of the cart hardware, install the Anode Panel onto the temporary spacers on top of the Cathode Inner Panel with the screw head of the cart hardware facing up and the Strip Side of the panel facing down. ☑

Note(s):

Ensure the O-rings remain in place as the Anode Panel is lowered over the Cathode Panel.

4.23 Remove the transport cart hardware and then the temporary spacers from the Inner Cathode Panel and lower the Anode Panel flush onto the Inner Cathode ensuring the O-rings stay in place, pushing it down flat onto the Cathode Panel Gap Bars. Remove the alignment pins from the alignment holes. ☑

Note(s):

Ensure the alignment pins remain perpendicular to the Panels.

4.24 Record the Serial number of the second Anode Panel onto the chart after step 4.42. ☑

Darren O Thomas
Technician(s)

3 Aug 2001
Date

Completed

4.25 Clean the Strip Side of a Cathode Inner Panel with Ethyl Alcohol (Fermi Stk. No. #1920-0600)and a low lint wipe (Fermi Stk No. 1660-2500), and blow both it off with Ionized air. ☑

4.26 Install and verify that all the O-rings (368020) are seated flat into there respective counter bores on the Strip Side of the panel. ☑

4.27 Lower the Inner Cathode Panel with the Strip Side facing down, onto the temporary spacers and over the Anode Panel on the assembly table ensuring all O-rings are present and in proper position. Install the temporary alignment pins into the alignment holes. Remove the temporary spacers from the Anode Panel, and lower the panel into place. Remove the alignment pins from the alignment holes. ☑

Note(s):

Ensure the alignment pins remain perpendicular to the Panels.

4.28 Clean the Non-Strip Side of the Cathode Inner Panel with Ethyl Alcohol (Fermi Stk. No. #1920-0600)and a low lint wipe (Fermi Stk No. 1660-2500), and blow both it off with Ionized air. ☑

4.29 Install and verify that all the O-rings (368020) are seated flat into there respective counter bores on the Non-Strip Side of the panel. ☑

4.30 Record the Serial number of the Inner Cathode Panel onto the chart after step 4.42. ☑

Darren Thom
Technician(s)

3 Aug. 2001
Date

4.31 Acquire the third Anode Panel and transport it to the Ionization Cleaning Station. Install Spacer Bars (368248) onto each side of the panel before performing the Air Knife procedure. ☑

4.32 Clean the third Anode Panel according to the Air Knife Operating Procedure. ☑

4.33 Inspect each hole and crevice to be sure it is clean and there is no debris, oil, dirt or particles and ensure the wires are free from any debris. ☑

4.34 Transport the third Anode Panel from the Ionization Cleaning station to the Chamber Assembly Table. Remove the Anode Panel from the transport cart and using temporary spacers between the third Anode Panel and the Inner Cathode Panel to allow room for removal of the cart hardware, install the Anode panel onto the temporary spacers on top of the Cathode Inner Panel with the screw head of the cart hardware facing up and the Strip Side of the panel facing down. ☑

Note(s):

Ensure the O-rings remain in place as the Anode Panel is lowered over the Cathode Panel.

Completed ☑

4.35 Remove the transport cart hardware and then the temporary spacers from the Inner Cathode Panel and lower the Anode Panel flush onto the Inner Cathode ensuring the O-rings stay in place, pushing it down flat onto the Cathode Panel Gap Bars. Remove the alignment pins from the alignment holes.

Note(s):

Ensure the alignment pins remain perpendicular to the Panels.

4.36 Record the Serial number of the third Anode Panel onto the chart after step 4.42. ☑

Darren O'Tham
Technician(s)

3 Aug. 2001
Date

4.37 Clean the Cathode Upper Panel (both sides) with Ethyl Alcohol (Fermi Stk. No. #1920-0600)and a low lint wipe (Fermi Stk No. 1660-2500). Blow the panel off with Ionized air. ☑

4.38 Install and verify that all the O-rings (368020) are seated flat into there respective counter bores. ☑

4.39 Lower the Upper Cathode Panel with the Gap Bar side facing down onto the temporary spacers and over the Anode Panel on the assembly table ensuring all O-rings are present and in proper position. Install the alignment pins in the alignment holes, and then remove the temporary spacers from the Anode Panel. Lower the Upper Cathode into place. ☑

Note(s):

Ensure the alignment pins remain perpendicular to the Panels.

4.40 Record the Serial number of the Upper Cathode Panel onto the chart after step 4.42. ☑

Darren O'Tham
Technician(s)

3 Aug. 2001
Date

4.41 Remove the two 12" long temporary alignment pins and install the two Alignment Pins (368011), one through the narrow end and one through the wide end of the panels.

Note(s):

Ensure the ring grooved end of the pins are inserted first down through the Upper Cathode Panel alignment holes.

Darren Thom
Technician(s)

3 Aug. 2001
Date

Panel Location	Panel Designation	Panel Serial No.#
Cathode Upper	ME234/2-UC-	095
Anode	ME234/2-A-	299
Cathode Inner	ME234/2-IC-	209
Anode	ME234/2-A-	297
Cathode Inner	ME234/2-IC-	208
Anode	ME234/2-A-	307
Cathode Lower	ME234/2-LC-	102

X 4.42 Ensure all panel serial numbers have been correctly recorded in the chart above.

Bill Van der Sden
Lead Person

8-3-01
Date

5.0 Chamber Framework Installation

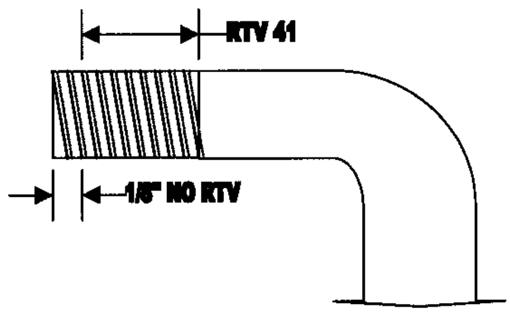
Completed

5.1 Clean all the parts of the framework with Ethyl Alcohol (Fermi Stk. No. #1920-0600) and low lint wipes (Fermi Stk No. 1660-2500). ☑

5.2 Cover all assembly bolts with Shrink Mylar Insulation Tubing and using the heat gun shrink the Mylar down over the bolts minimizing bunching and wrinkles in the Mylar. ☑

5.3 Install appropriate bolts (368051 and 368053) through all the wide end panel assembly holes taking care NOT to tear the Mylar insulation. ☑

5.4 Apply a bead of RTV41 to the threads on Gas Tubes (368008 and 368009) as shown below, and install Tubes into the appropriate threaded hole in the Upper and Lower Cathode Panels. ☑



Note(s):

Ensure NO RTV is on the first 1/8" of the thread.

5.5 The "U" type tube is on the right side of the chamber, and "Z" type tube on the left. Thread the tubes inward until torque increases significantly, then continue until open end of tube points vertically. ☑

5.6 Install the Bulkhead Connectors (368022) into the Upper Wide End Extrusion. ☑

5.7 Install the Gas Connector Elbows (368116) onto the Bulkhead Connectors. ☑

5.8 Install the top and bottom Wide End Extrusions (368067 and 368068) over the bolts onto the chamber and secure with nuts. ☑

Note(s):

ONLY HAND TIGHTEN the nuts onto the bolts.

5.9 Carefully connect the Gas Tubes into the Bulkhead Connectors ensuring to only hand tighten the connector nuts. ☑

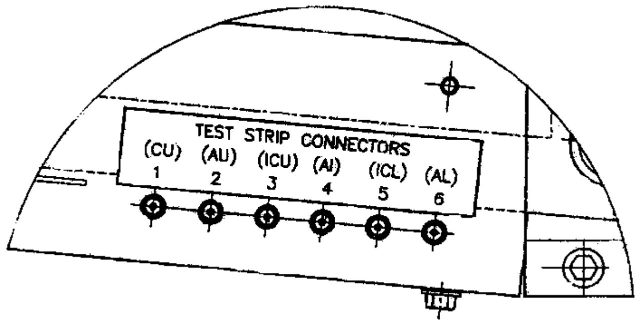
5.10 Install the remainder of the bolts around the perimeter of the chamber in the panel assembly holes taking care NOT to tear the Mylar insulation. ☑

Bill Vandyke — Technician(s)

8-3-01 — Date

Completed

5.11 Install the LEMO Connectors (MA-368097 [6 ea.] into the top High Voltage side extrusion near the wide end. ☑



5.12 Install the High Voltage Side top and bottom side extrusions (368065 and 368066) over the bolts onto the chamber and secure with nuts. ☑

Note(s):

ONLY HAND TIGHTEN the nuts onto the bolts.

5.13 Install the Anode Side top and bottom Notched side extrusions (368063 and 368064) over the bolts onto the chamber and secure with nuts. ☑

Note(s):

ONLY HAND TIGHTEN the nuts onto the bolts.

5.14 Install top and bottom Narrow End Extrusions (368061 and 368062) over the bolts onto the chamber and secure with nuts. ☑

Note(s):

ONLY HAND TIGHTEN the nuts onto the bolts.

5.15 Install the End Stiffening Plates on the Narrow end. ☑

5.16 Assemble the O-rings (368020) into the Brass Nuts (368006) and then assemble the nuts to the Assy. Studs (368005 and 368006) through the center holes of the panels. Hand tighten the nuts. ☑

Bill Van der Sol ________ 8-3-01 ________
Technician(s) Date

X 5.17 Dry fit remaining Frame Assy. parts to ensure extrusions have been installed correctly. ☑

Note(s):

ENSURE ALL REMAINING PARTS HAVE BEEN DRY FIT BEFORE CONTINUING ASSEMBLY OF CHAMBER!

G. Battistoni ________ 8-3-01 ________
Lead Person Date

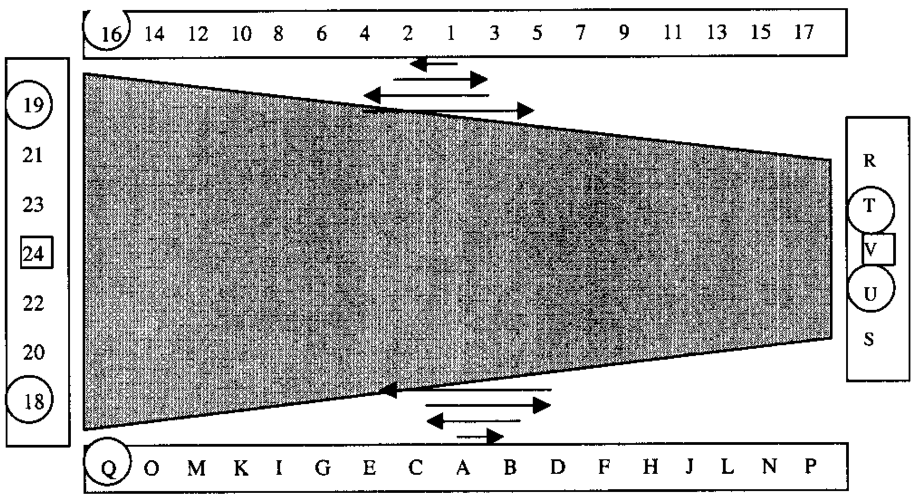
Completed

Note(s):

Tightening of Chamber Bolts is a process that requires two technicians.

5.17 Torque the Center Assy. Brass Studs to 25 inch pounds. ☑

5.18 With one Tech starting at the 9th bolt from the narrow end, High Voltage side (marked as position "1" on the drawing below) and the other Tech starting at the 9th bolt from the wide end on the Anode side (marked as position "A" on the drawing below), torque bolts "A-1" to 25 inch pounds. ☑



5.19 Each Tech then moves to his/her next successive bolt (from "1" to "2", and from "A" to "B") and torque it to 25 inch pounds. Continue to torque bolts to 25 inch pounds in sequential order (A-1, B-2, C-3…) until all bolts at torqued except the bolts with a circle or square (bolts 16,18, 19, 24,Q,T, U and V) in above diagram. ☑

5.20 Check to ensure 6 E-rings are in place, along with a Jam Nut before attempting to torque the Z-Bracket Bolts (those circled in above diagram). ☑

5.21 Torque Z-Bracket Bolts (16,18,19,Q,T and U) to 20 inch pounds. ☑

Note(s):

Do NOT attach Snap Rings or attempt to torque Alignment Bolts (24 and 'V' in squares above) at this time.

5.22 In the same manner and order as steps 5.18 and 5.19, torque all bolts to 45 inch pounds, EXCEPT Z-Bracket and Alignment bolts (those with a circle or square in above diagram). ☑

5.23 In the same manner and order as step 5.22, torque bolts to 55 inch pounds. ☑

Technician(s): J. Batteston

Date: 8-6-01

Completed

5.24 Torque Z-Bracket Bolts (16,18,19,Q,T and U) to 30 inch pounds. ☑

5.25 Once Z-Bracket Bolts have been torqued to 30 Inch pounds, remove the Jam Nuts from the bottom of the bolts. ☑

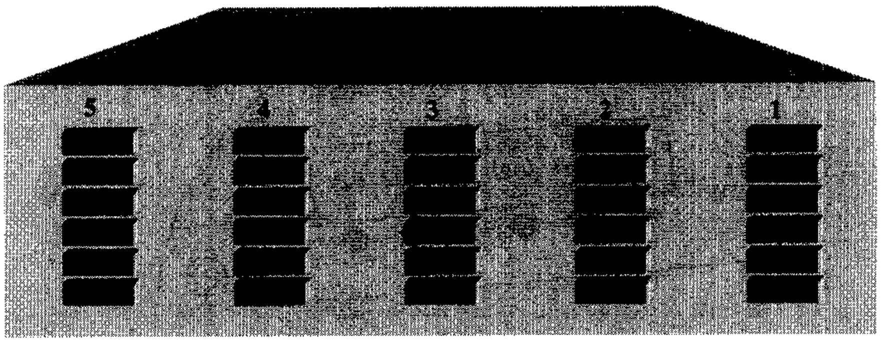
5.26 Re-torque Center Assy. Brass Studs to ensure they have remained at 25 inch pounds. ☑

Technician(s): [signature]

Date: 8-6-01

6.0 Chamber Cathode Strip Resistance Test / 51 Ohm Resistor Check

6.1 Using a Multimeter, and a Toggle Switch Box, check the continuity in resistance of the cathode strip connectors. In accordance with the drawing, test each connector and if it passes, check it off in the chart below. If it fails, write the resistance value in the "Fail" box.



Plane # 1
Plane # 2
Plane # 3
Plane # 4
Plane # 5
Plane # 6

Note(s):
All measurements must be within the range of 0.9 – 1.1 Meg Ohm.

	5		4		3		2		1	
	Pass	**Fail**	**Pass**	**Fail**	**Pass**	**Fail**	**Pass**	**Fail**	**Pass**	**Fail**
Plane #1	✓		✓		✓		✓		✓	
Plane #2	✓		✓		✓		✓		✓	
Plane #3	✓		✓		✓		✓		✓	
Plane #4	✓		✓		✓		✓		✓	
Plane #5	✓		✓		✓		✓		✓	
Plane #6	✓		✓		✓		✓		✓	

Remarks:____________________

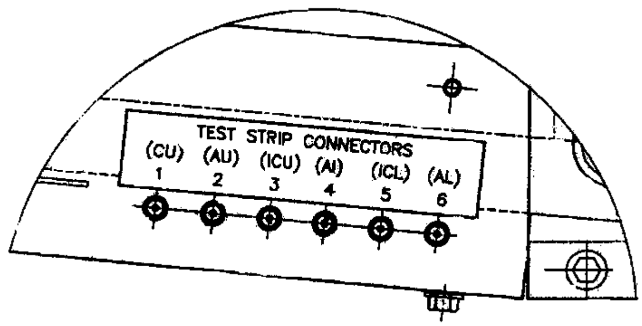
Note(s):
After measurements are completed inform supervisor of any failures.
If all pass continue.

Bill Vandegraaf
Technician(s)

8-6-01
Date

Completed ☑

6.2 Connect the six (6) Test Cable Assemblies (368099) to the six (6) LEMO Connectors near the wide end of the chamber.



6.3 Plug a Multimeter into each LEMO Connector separately to measure the resistor value of the 51Ohm resistors. Resistor value should read between 48 Ω to 54 Ω.

Resistor	Pass	Fail
Upper Cathode (CU)	X	
Anode (AU)	X	
Inner Cathode (ICU)	X	
Anode (AI)	X	
Inner Cathode (ICL)	X	
Anode (AL)	X	

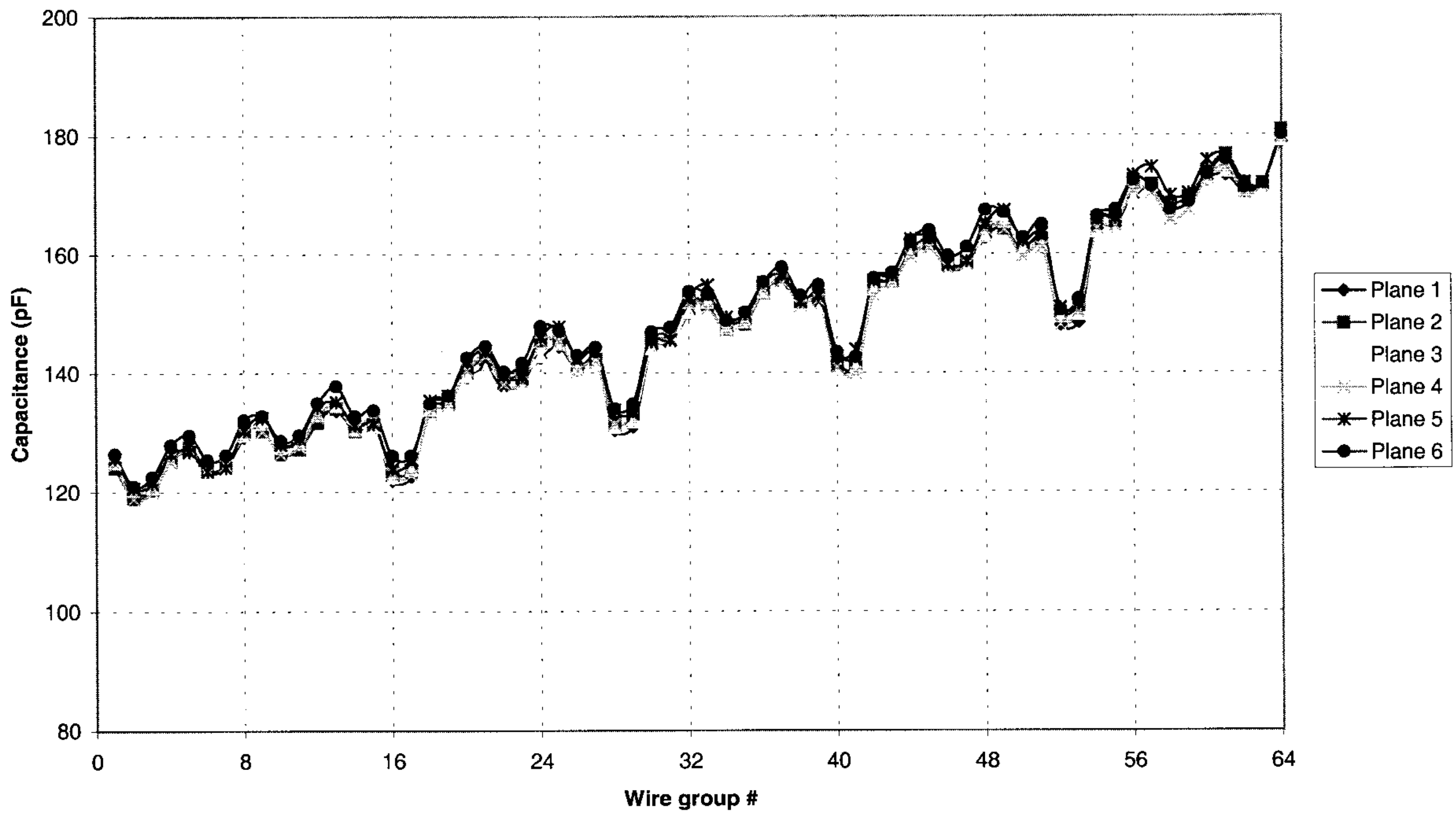
Note(s):

After measurements are completed inform supervisor of any failures.
If all pass continue.

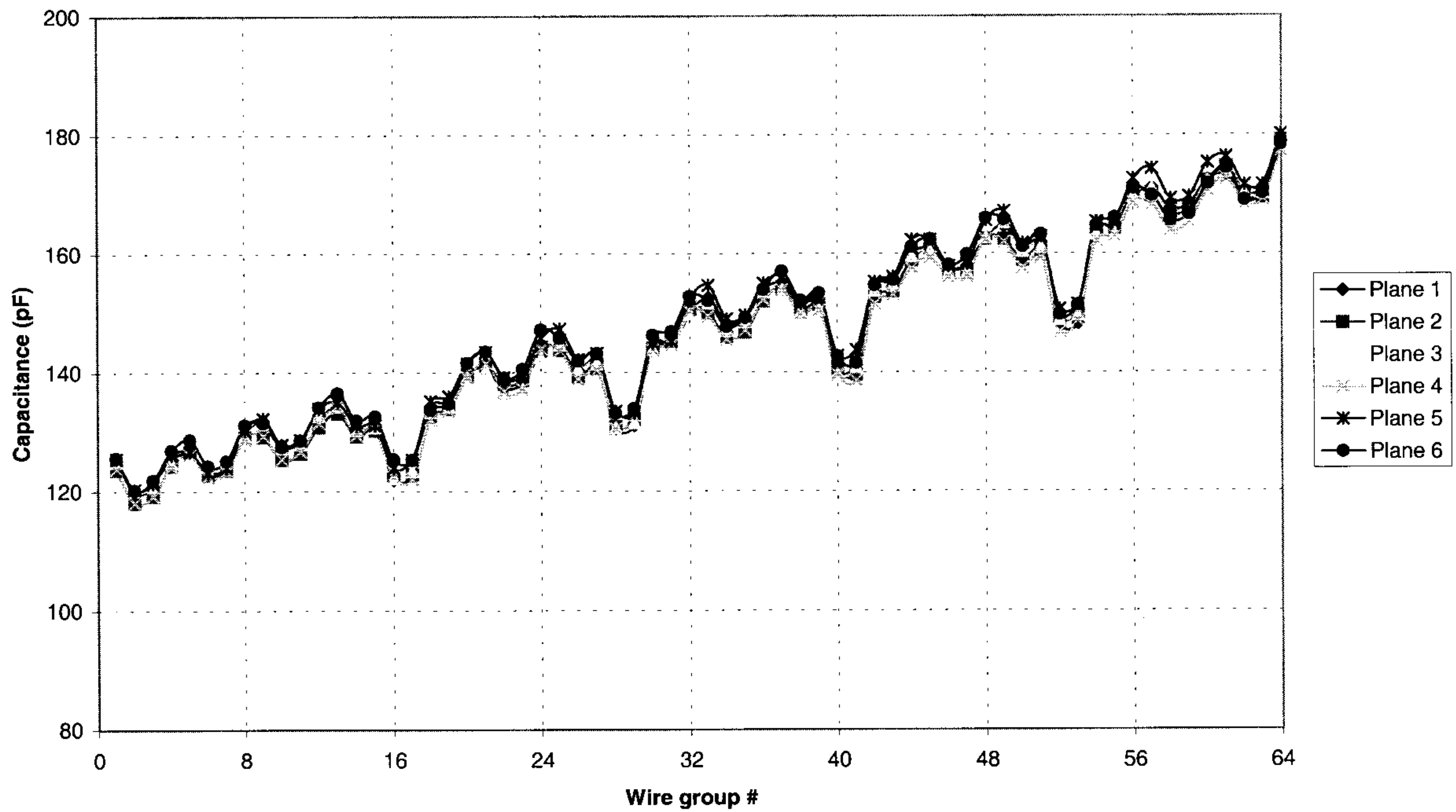
M. Batteson
Technician(s)

8-6-01
Date

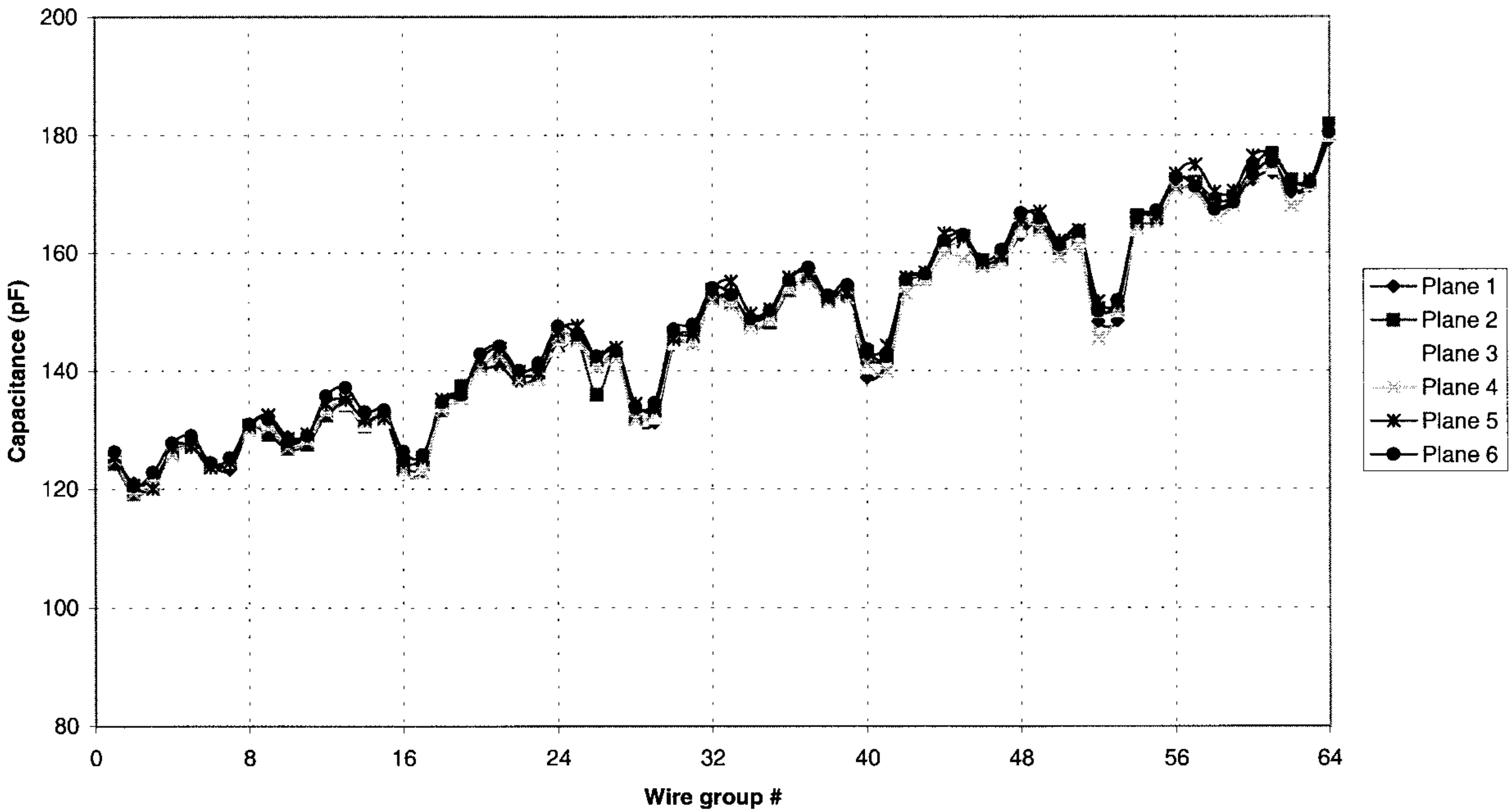
ME234/2-045 Wire Capacitance
August 06, 2001
(before full assembly)



ME234/2-045 Wire Capacitance
August 09, 2001
(before full assembly)



ME234/2-045 Wire Capacitance
August 16, 2001
(after full assembly)
File name: ME234_2_045_3_w.xls



Chamber Anode Wire Group Capacitance Measurement

ME234/2-045

		Protection Board #1							
Wire Group		1	2	3	4	5	6	7	8
Non-Strip	**Plane 1**	125.52	121.00	121.52	126.28	126.99	124.17	123.29	130.36
Strip	**Plane 2**	124.30	119.20	120.55	125.77	127.38	123.93	124.90	130.43
Non-Strip	**Plane 3**	126.34	120.34	121.36	125.79	126.83	123.52	124.59	129.88
Strip	**Plane 4**	125.11	119.37	120.55	125.77	127.21	123.61	124.58	129.94
Non-Strip	**Plane 5**	125.52	120.67	120.06	127.09	127.16	123.68	124.59	130.69
Strip	**Plane 6**	126.25	120.50	122.82	127.73	129.00	124.42	125.23	130.92

		Protection Board #2							
Wire Group		9	10	11	12	13	14	15	16
Non-Strip	**Plane 1**	132.35	128.81	129.15	133.42	134.16	131.03	131.74	122.57
Strip	**Plane 2**	129.17	126.84	127.54	132.45	134.21	130.60	131.89	124.08
Non-Strip	**Plane 3**	131.05	128.32	128.66	133.58	134.48	130.87	131.42	122.73
Strip	**Plane 4**	130.47	127.01	128.19	132.94	135.03	131.74	132.38	123.10
Non-Strip	**Plane 5**	132.52	128.49	129.31	134.40	135.13	131.68	132.07	124.68
Strip	**Plane 6**	131.77	127.98	129.00	135.71	137.14	133.04	133.35	126.36

		Protection Board #3							
Wire Group		17	18	19	20	21	22	23	24
Non-Strip	**Plane 1**	123.08	134.84	135.47	139.75	140.67	137.89	139.06	143.35
Strip	**Plane 2**	123.82	133.34	137.46	140.43	143.00	139.22	140.18	145.89
Non-Strip	**Plane 3**	123.73	134.19	134.50	139.75	139.37	136.58	137.76	143.52
Strip	**Plane 4**	122.68	133.34	135.35	140.59	142.51	138.40	138.55	145.73
Non-Strip	**Plane 5**	125.36	135.17	136.61	142.03	143.76	139.85	139.71	146.60
Strip	**Plane 6**	125.76	134.64	136.00	142.87	144.14	140.03	141.32	147.52

		Protection Board #4							
Wire Group		25	26	27	28	29	30	31	32
Non-Strip	**Plane 1**	144.88	140.87	142.29	131.31	131.23	144.42	144.91	151.64
Strip	**Plane 2**	145.08	135.94	142.18	131.96	133.24	145.56	146.84	152.24
Non-Strip	**Plane 3**	144.71	141.03	141.96	131.31	132.04	144.59	145.08	150.66
Strip	**Plane 4**	145.08	140.49	142.02	131.64	133.72	145.23	144.57	151.91
Non-Strip	**Plane 5**	147.64	142.33	143.91	134.40	133.67	145.40	146.21	153.75
Strip	**Plane 6**	146.05	142.45	143.32	133.92	134.54	147.02	147.82	154.03

Technician: June Pd **Date:** 8/16/01

Chamber Anode Wire Group Capacitance Measurement

ME234/2-045

Wire Group		Protection Board #5							
		33	34	35	36	37	38	39	40
Non-Strip	**Plane 1**	152.68	148.36	149.75	153.88	154.99	152.10	152.07	138.81
Strip	**Plane 2**	151.57	147.48	148.20	153.62	155.53	151.73	153.34	142.31
Non-Strip	**Plane 3**	152.03	147.38	148.78	154.21	154.34	150.79	150.93	140.43
Strip	**Plane 4**	150.92	147.16	148.69	153.95	155.37	151.41	152.36	141.17
Non-Strip	**Plane 5**	155.12	149.66	150.40	155.83	156.46	152.43	153.21	143.19
Strip	**Plane 6**	152.87	148.78	150.15	155.25	157.49	152.71	154.48	143.61

Wire Group		Protection Board #6							
		41	42	43	44	45	46	47	48
Non-Strip	**Plane 1**	141.14	154.87	155.75	160.54	161.02	157.82	158.25	163.00
Strip	**Plane 2**	142.32	154.47	155.68	160.79	162.69	158.73	159.03	164.77
Non-Strip	**Plane 3**	141.46	154.38	155.75	160.38	161.02	157.16	157.60	163.65
Strip	**Plane 4**	139.88	153.01	155.19	159.65	158.95	157.59	158.54	164.44
Non-Strip	**Plane 5**	144.23	155.85	156.73	163.30	162.81	158.31	159.55	165.76
Strip	**Plane 6**	142.32	155.45	156.33	162.09	163.02	158.73	160.49	166.72

Wire Group		Protection Board #7							
		49	50	51	52	53	54	55	56
Non-Strip	**Plane 1**	165.04	161.23	162.40	148.36	148.48	164.35	164.91	170.15
Strip	**Plane 2**	164.39	160.81	162.51	150.53	150.98	166.37	166.50	172.42
Non-Strip	**Plane 3**	165.69	161.23	161.92	149.98	150.11	163.86	164.26	170.15
Strip	**Plane 4**	163.91	159.35	161.21	145.48	150.32	164.42	165.04	170.79
Non-Strip	**Plane 5**	167.00	162.04	163.86	151.77	151.41	165.82	166.38	173.39
Strip	**Plane 6**	165.86	161.30	163.65	150.04	151.95	165.88	167.15	172.75

Wire Group		Protection Board #8							
		57	58	59	60	61	62	63	64
Non-Strip	**Plane 1**	171.39	167.74	168.89	172.39	173.55	170.23	171.25	179.08
Strip	**Plane 2**	172.02	168.94	169.51	174.47	176.85	172.38	171.86	181.86
Non-Strip	**Plane 3**	171.55	166.27	167.76	173.20	174.36	171.05	171.58	179.89
Strip	**Plane 4**	170.24	166.01	168.05	172.84	175.06	167.99	171.54	180.07
Non-Strip	**Plane 5**	174.96	170.35	170.52	176.45	176.48	172.36	172.39	181.03
Strip	**Plane 6**	171.21	167.31	168.53	173.17	175.39	170.59	171.86	180.39

Technician: June Fell **Date:** 8/16/01

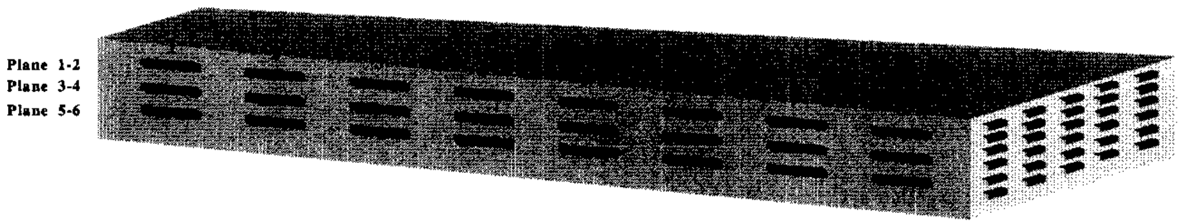
Completed

7.0 Chamber Anode Wire Group Capacitance Measurements

7.1 Using a Capacitance Measuring Unit, measure the anode wire group capacitance from the protection boards. Begin measuring from the narrow side of Chamber.

Note(s):

After measurements are completed inform supervisor of any discrepancy with reference data table with the capacitance measurements.



		PASS	FAIL
7.1.1	Protection Board #1 measurement	☑	☐
7.1.2	Protection Board #2 measurement	☑	☐
7.1.3	Protection Board #3 measurement	☑	☐
7.1.4	Protection Board #4 measurement	☑	☐
7.1.5	Protection Board #5 measurement	☑	☐
7.1.6	Protection Board #6 measurement	☑	☐
7.1.7	Protection Board #7 measurement	☑	☐
7.1.8	Protection Board #8 measurement	☑	☐

7.2 Attach the chamber anode wire group capacitance measurement report to this traveler. ☑

7.2.1 Record the number of pages in the report 5.

Remarks:______________________________

June Fal
Technician(s)

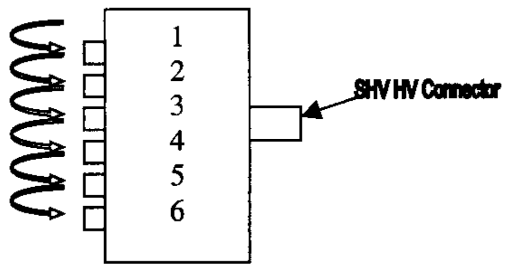
8/16/01
Date

8.0 Chamber High Voltage (HV) Electrical Test in Air

Completed

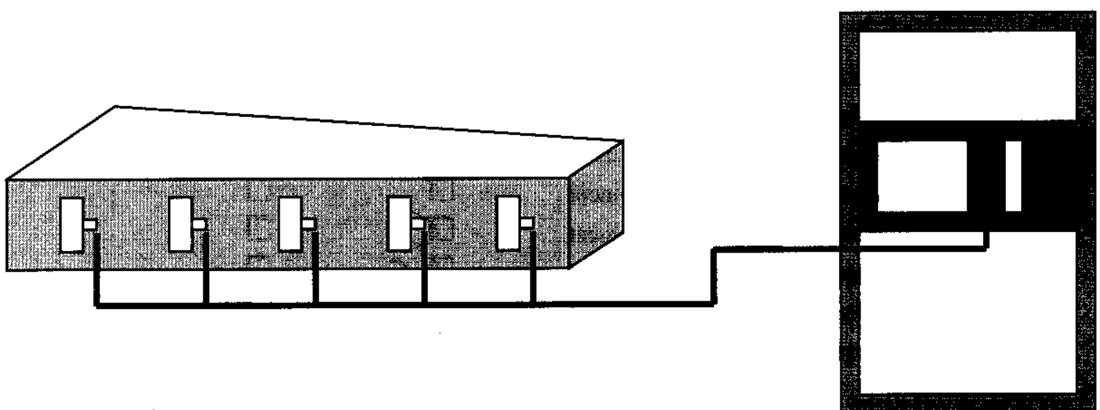
8.1 Attach the five (5) HV Glastic Channels to the Chamber. ☑

8.2 Connect the HV banana jumpers to the HV Glastic Channels. ☑



8.3 Connect together six (6) ground plugs (one from each plane) on the wide end of the Chamber. ☑

8.4 Connect the HV red cables from the HV power supply to the Glastic SHV HV Connectors.



G. Pattestos
Technician(s)

8-6-01
Date

Completed

Note(s):

High Voltage Test should not be performed for longer than 30 minutes.

8.5 Slowly raise the High Voltage up to 3.8 kV (2-3 minutes per voltage step) and record the current data from the Chamber onto the Table below. ☑

	Chamber All Panels	Time		Segment #				
				1	2	3	4	5
HV kV	I µA	Start	Stop	I µA	I µA	I µA	I µA	I µA
1.0	.12	8:20	8:22					
2.0	.16	8:22	8:24					
3.0	.24	8:24	8:26					
3.2	.40	8:26	8:28					
3.4	.45	8:28	8:31					
3.6	.80	8:31	8:33					
3.7	1.00	8:33	8:36					
3.8	1.6	8:36	8:45	.6	2	.2	.2	.4

8.6 When the Voltage is at 3.8 kV, record the current from each HV Segment onto the table. ☑

Note(s):

If Corona or a high current (more than 5 µA per HV Segment) occurs, make a note in the corresponding area above, disconnect that Segment and continue to raise the HV in accordance with the procedure.

Notify the supervisor if any discrepancy occurs.

8.7 When the HV test is complete, turn the High Voltage off SLOWLY. Wait until the HV drops to 30 volts (30mV on the voltmeter). ☑

8.8 Disconnect the red HV cables from the Chamber. ☑

8.9 Remove the HV Glastic Channels and place the screws back in the mounting plates. ☑

[signature] 8-6-01

Technician(s) Date

9.0 Chamber Sealing

Completed

9.1 Transport Chamber to appropriate Sealing Station (if different from Assembly Table).

9.2 Prepare RTV dispensing equipment.

9.2.1 Acquire Pneumatic Dispenser (368712), Dispensing Cartridge (368715), Mixing Nozzle (368717, 368718), and Dispensing Needle (368698).

9.2.2 Fill the LARGE section of the Dispensing Cartridge with RTV 41, and fill the SMALL section with RTV 9811 Hardener.

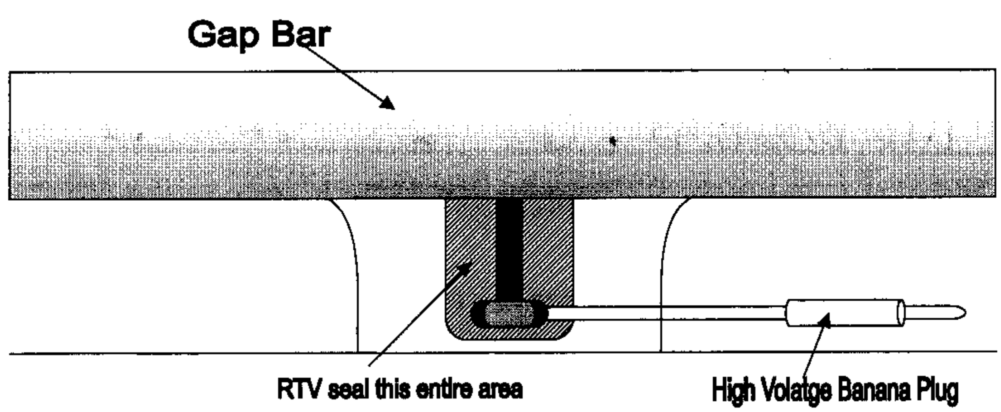
9.2.3 Into the Pneumatic Dispenser, place the Dispensing Cartridge, and then attach the Mixing Nozzle and Dispensing Needle.

9.2.4 Hook up the Pneumatic Dispenser to House Air.

9.3 Using Pneumatic Dispenser, seal the gaps between Anode Panels and Cathode Gap Bars along all panels. Apply approximately 1/8" fillet bead of RTV. Ensure RTV is applied behind all components, around all the corners and in all vertical gaps between Gap Bars.

Note(s):

When sealing behind the HV Banana plug connector, completely cover the High Voltage Solder Joint and conductive pad as shown. Verify proper sealing with the RTV and eliminate any and all void areas.



9.4 Allow the RTV to set up for 4 hours before continuing.

9.5 Rotate Chamber 180°, so the Lower Cathode Panel is now on top. Seal all remaining gaps in a similar manner.

9.6 Let the Chamber to sit for 24 hours to allow the RTV to cure.

Technician(s) ________ Date 8 15·01

10.0 Leak Check (Digital Leak Rate System)

Completed

Note(s):

Never at any point during the test should the technician walk away. The Technician must pay close attention when the test is being preformed.

Every time this test is performed it should be performed at the same barometric pressure.

10.1 Set the Main Valve and Microcalibrator Valve to the closed/off position. ☑

10.2 Turn on both the Microcalibrator Power Switch (Panel Front) and the Sen-I-Tran Power Switch (Back Panel). ☑

10.3 Set the bottle pressure gauge regulator to 15psi. ☑

10.4 Connect a clean dry Argon supply to gas input on the back panel of the Leak Measurement Device. Tighten the connections 1/8 turn past finger tight. ☑

10.5 Open Argon bottle valve. ☑

Note(s):

Ensure pressure gauge on Argon bottle reads 15psi.

10.6 Verify the System Pressure Gauge on the back panel reads 12 inches Water Column. ☑

10.7 Turn the Main Valve to ON. Turn the Microcalibrator Valve to OPEN. Flow of gas through the Leak Measurement Device shall now occur. ☑

10.8 Open the Flow Adjustment Valve (counter-clockwise) to allow the mechanical flowmeter to reach full scale (130 ccm). The Microcalibrator will give an error reading at this point since the actual flow exceeds its working range. ☑

10.9 Turn down the flow rate to the point where the Microcalibrator is reading 10ccm. This procedure verifies that the delivery system is properly working and allows for purging of the Leak Measurement Device. ☑

10.10 Turn the Main Valve to OFF.

10.11 Verify the Sen-I-Tran (Chamber Pressure) Gauge reads between –0.015 and +0.015 inches of water. ☑

10.12 Connect the Test Ports (Chamber Pressure and Flow To Chamber) of the Leak Measurement Device to the Chamber Bulkhead Connectors. (It does NOT matter which tube is connected to which port) ☑

10.13 Verify the Sen-I-Tran (Chamber Pressure) Gauge still reads between –0.015 and +0.015 inches of water. ☑

Completed

10.14 Turn the Main Valve to begin the flow. The Microcalibrator should read 10ccm. To pressurize the chamber, increase the gas flow by turning the Flow Adjustment Valve until the mechanical flowmeter reads its full value of 130 ccm. The chamber pressure should immediately begin increasing. Within a 10-15 minutes the pressure should read 2.9 inches. When it does, reduce the flow rate gradually so that the target pressure of 3.00 inches is gradually approached

10.15 Close the bottle, pressure regulator valve, and microcalibrator valve.

10.16 Turn the main valve to gas flashing position to drop the pressure on the manometer to 0 (backside of LMD) and then turn main valve to close position.

10.17 Wait for 5 minutes before starting the measurements. Using the weather station device for measurements of atmospheric pressure, temperature and humidity.

10.18 Leak test the chamber for 16-24 hours. Record a few measurements at the beginning and at the end of the leak test measurements at intervals of 1-2 hours. Record data in the table below.

#	Chamber Pressure (P) inch, Water	Barometric Pressure (B) inch, Hg	Temperature F°	Humidity %	Time T h/min	Date day
1	3.04	29.03	70.7	35%	3:30PM	8-9-01
2	3.06	29.23	67.1	34%	7:45Am	8-10-01
3	3.					
4						
5						
6						
7						
8						
9						
10						

10.19 Calculate leak rate in accordance with the formula below.

$$\text{Leak rate (cm}^3\text{/min)} = \frac{3000\,(2\Delta P + 13.6\,\Delta B)}{(\Delta P_{final} + \Delta P_{initial})\ \Delta T}$$

Where: $\Delta P = P_{initial} - P_{final}$, chamber pressure in inch water,
$\Delta B = B_{initial} - B_{final}$, barometric pressure in inch Hg
$\Delta T = T_{final} - T_{initial}$, minutes,

10.20 Record result of the leak rate calculation in the table below.

Leak rate, cm^3/min	Date

Note(s):

Leak Flow Rate MUST be less than $2.0cm^3/min$.
If chamber passes leak rate test proceed to step 11.0.

10.21 If leak rate is higher than 2.0cc/min start procedure for definition of lead location using a leak detector. Record results of leak investigation below.

Cause Of Leak: LEAK WAS FOUND AT GAS TUBE
RESEALED & RECHECK

10.22 When leak is fixed, repeat leak test measurements. Record a few measurements at the beginning and at the end of the leak test measurements at intervals of 1-2 hours. Record data in the table below.

10.23 Turn off the Sen-I-Tran Unit; disconnect the gas lines to the chamber.
Install Cap-Plug (368119) over the gas connectors on the Chamber to keep it free of contaminants.
Zip tie the Compression Nuts (368117) to the Gas Connectors for safe transportation.

#	Chamber Pressure (P) inch, Water	Barometric Pressure (B) inch, Hg	Temperature F°	Humidity %	Time T h/min	Date day
1	3.09	29.41	65.3	40%	8:00AM	8-14-01
2	3.27	29.38	67.1	34%	10:30AM	8-14-01
3	3.49	29.38	68.0	34%	11:45AM	8-14-01
4	4.12	29.32	68.0	33%	2:00PM	8-14-01
5	4.38	29.32	67.1	33%	3:50PM	8-14-01
6	4.63	29.23	65.3	39%	7:30AM	8-15-01
7						
8						
9						
10						

Note(s):

Temperature must not be more than + – 2° Fahrenheit during measurements.

10.24 Calculate leak rate in accordance with formula (see 10.19). Record result of the leak rate calculation in the table below.

Leak rate, cm^3/min	Date
-0.21	8-14-01

Note(s):

Leak Flow Rate MUST be less than $2.0 cm^3/min$.

Remarks:

Technician(s) ______ Date 8-14-01

X 10.25 Verify all Section 10.0 steps have been properly completed and signed off and the panel is acceptable for further processing.

Helen Jansen
Lead Person

8/14/01
Date

11.0 High Voltage Chamber Wiring

Completed

11.1 Install Switchboard Terminal Channel (MA-368007 [5 ea.]) onto the High Voltage Chamber Side using Polycarbonate RHS Screws (MA-368328 [10 ea.]) and Mounting Plater (MA-368012) [5 ea]). ☑

11.2 Install Switchboard Terminal (MA-368021 [18 ea]) onto Switchboard Terminal Channel. ☑

11.3 Install the HV cable assembly (MA-368102 [1 ea.]) using screws M5 X 1" Thread Forming Screws (MA-368075) (supplied with chamber frame) along the length of the chamber. ☑

11.4 Secure the HV cable to the chamber using cable ties (MA-368027 [1 ea]) and cable ties (MA-368027 [6 ea]). Remove excess wire tie ends by cutting with approved cutters. ☑

11.5 Plug in HV Banana Plug Assy's into the Switchboard Terminals. ☑

Darren Thom
Technician(s)

8-15-2001
Date

12.0 Soldering Foil

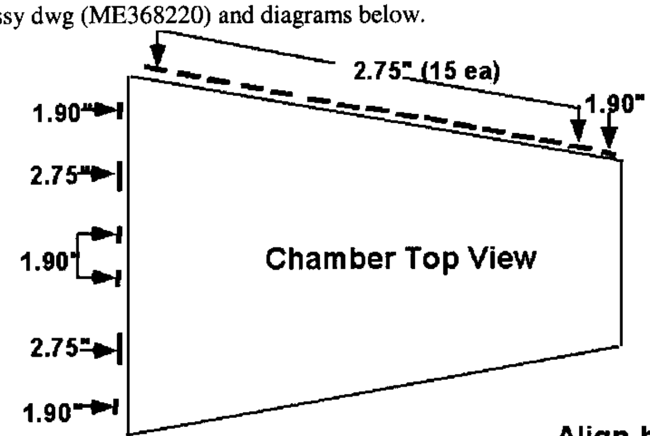
Completed

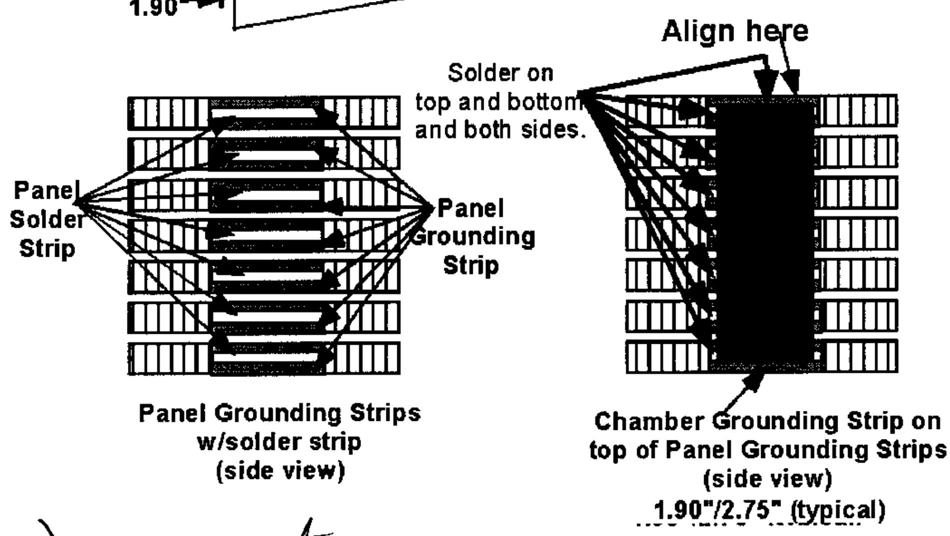
Note(s):

To install the Chamber Grounding Strips (MA-368107 & MA-368101), place the Strips on top of the panel grounding strips and solder in the correct locations in accordance with ME234/2 Chamber Final Assy dwg (ME-368220). Ensure prior to installing the Chamber Grounding Strips, that all the Panel Grounding Strips have a solder strip. Place the Chamber Grounding Strip onto the Upper Cathode Panel aligning to center of the solder strip and solder. Solder the Chamber Grounding Strip to all the other panels working from top to bottom. Solder must hold down the edge of the Chamber Grounding Strips to the Panel Grounding Strips. While soldering the Chamber Grounding Strip to other panels, keep the Chamber Grounding Strip tight and free of wrinkles, bumps and other imperfections.

12.1 Install 5 ea Grounding Strips 6.00 x 1.90" (MA-368107) onto the Chamber as per Final Assy dwg (ME-368220) and diagrams below. ☑

12.2 Install 17 ea Grounding Strips 6.00 x 2.75" (MA-368101) onto the Chamber as per Final Assy dwg (ME368220) and diagrams below. ☑





Technician(s): [signature]

Date: 15 Aug, 2001

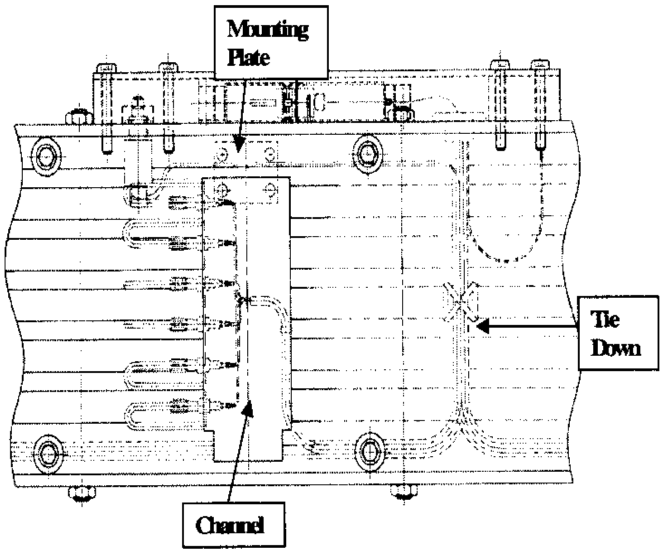
13.0 High Voltage Cable Assembly

Completed

13.1 Tape kapton to the mounting plate (MA-368012 [5 ea.]). ☑

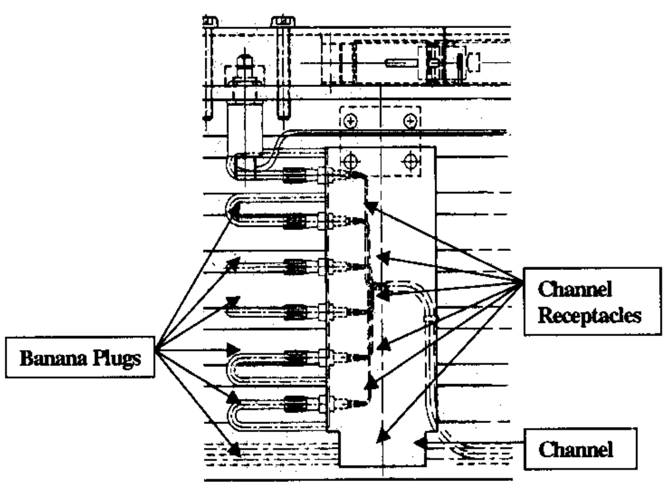
13.2 Secure the mounting plate (MA-368012) to the top HV side extrusion using the pan head screws (MA-368015), with the kapton towards the chamber. ☑

13.3 Attach the HV channel to the mounting plate using polycarbonate RHS screws (MB-368328). ☑



Chamber Side View

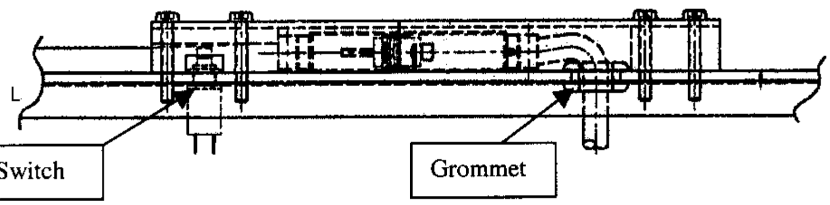
13.4 Plug in the HV banana plugs to the HV channel receptacles. ☑



Chamber Side View

Completed ☑

13.5 Route the wires so they are in the bottom HV side extrusion, and the connector is on top of the top HV side excrusion. Place the grommet around the wires for the HV extrusion will not cut through the wires. ☑



Chamber Side View

13.6 Place the first nut all the way down on the switch, and then install the switch to the top HV side excrusion, then tighten the second nut on the switch. ☑

13.7 Strip the wires about a ¼" down, and twist the wires together except wires 31 and 36. Solder the five wires to the grounding strip on the upper cathode panel. ☑

13.8 Two pieces of shrink tubing should be placed over wires 31 and 36, and then solder the wires to prongs on the switch, and heat the shrink tubing around the prongs and wires. ☑

Note(s):

If wires 31 and 36 are to short splice a small piece of wire to 31 and 36, then Solder them together. Place shrink tubing over the splice and heat the shrink tubing

13.9 Run two cable ties trough the two holes on the middle anode panel, and tie down the group of wires to the panel with the cable ties. ☑

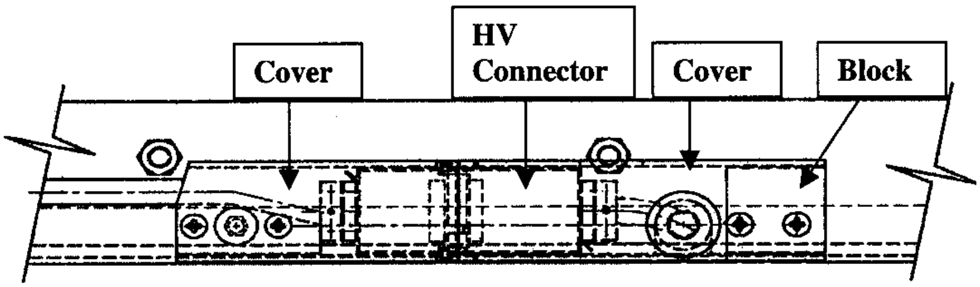
13.10 Tap (M6-1) the four holes in the top HV side excrusion for the HV cable assembly. ☑

Note(s):

The hole tapping may only be required on the early production excrusion Where tapping operation was not included.

Completed

13.11 Position the connector and block on the top HV side excrusion, and then place the cover over the connector and block and secure with the screws that are provided. ☑



13.12 Plug the adapter into the HV connector, push the switch and if the red light comes on the HV harness passes. Pass ☑ Fail ☐

13.13 Place the left cover and screws in a baggie and tape to the top of the chamber. ☑

Darrel G Thom
Technician(s)

Date 8-15-2001

14.0 Chamber Final

Completed

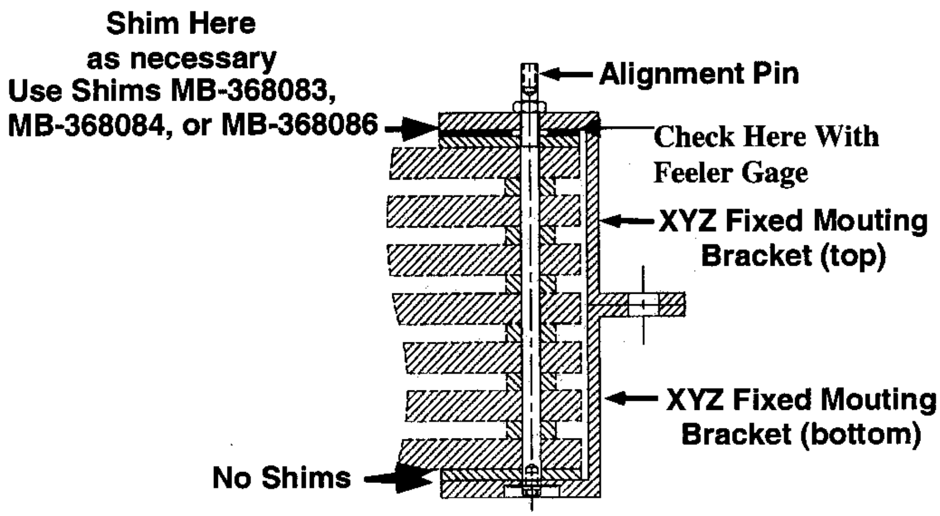
14.1 Install Z-Brackets onto the Wide End (368043, 368044, 368058 and 368059 [Qty. 2 complete brackets]) and Narrow End (368045 and 368060 [Qty. 1 complete bracket]).

14.2 Screw the Z-Brackets together with Flat Head Screws (368077).

14.3 On the Narrow end, fill the gap between the top Z-Bracket and the Frame Extrusion with the Shims according to Dwg. ME-368229 and drawing below.

Note(s):
Shims are to be installed ONLY on the TOPSIDE of the Chamber.

14.4 Once the gap is almost filled in, use the Feeler Gauge to determine the correct size of the last Shim. Use the Shim with the closest width to the measurement.



Chamber Narrow End
Side view of Center

14.5 After Z-Brackets and shims are assembled, check the measurement with a feeler gage. The measurement will be less then 4 mils.

14.6 Once the correct size Shims have been determined, record which size Shims were used in the chart below.

Narrow End Z-Bracket Shims Used
50
50
30
20

Bill Vanderhoof
Technician(s)

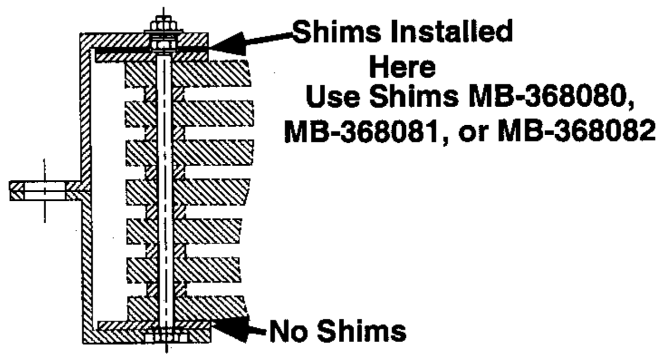
8-17-01
Date

14.7 On the Wide end, fill the gap between the top Z-Brackets and the Frame Extrusion with the Shims according to Dwg. ME-368229 and drawing below.

Note(s):

Shims are to be installed ONLY on the TOPSIDE of the Chamber.

14.8 Once the gap is almost filled in, use the Feeler Gauge to determine the correct size of the last Shim. Use the Shim with the closest width to the measurement.



Chamber End View (Wide End)

14.9 Once the correct size Shims have been determined, record which size Shims were used on each corner Z-Bracket in the chart below.

Wide End Z-Bracket Shims Used	
High Voltage Side	**Anode Side**
50	50
50	50
30	30
20	20

Bill [signature] ____ Technician(s)

8-17-01 ____ Date

14.10 On top of Chamber, place approximately three Flat Washers (368056) into each of the recessed holes of the Z-Brackets so they are just below flush. Then place one Washer (368010) over those followed by one Hex Nut (368039).

14.11 With the washers and nuts attached to the top of the panel, thread one Hex Nut (368039) onto the bottom side of the bolts and torque to 50 to 60 inch pounds.

Completed

14.12 Attach the Snap Rings (368018 [Qty. 2]) to the Alignment Bolts, one on the Wide End, and one on the Narrow End. ☑

Note(s):
The Snap Ring on the Wide End goes into the SECOND groove from the bottom end of the Pin, and the Snap Ring on the Narrow End goes into the first groove from the bottom end of the Pin.

14.13 Torque the Jam Nut (368055) on both Alignment Pins to 25 inch pounds. ☑

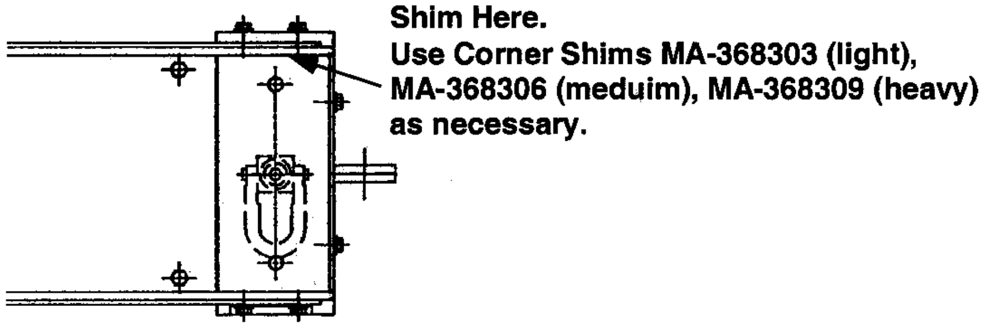
14.14 Install the Small End Plates (368075) onto the outer edges of the Narrow End according to Dwg ME-368229. ☑

14.15 Install the Big End Plates (368074) onto the outer edges of the Wide End according to Dwg. ME-368229. ☑

14.16 Fill the gap between the top of all the End Plates and the Frame Extrusions with the Shims according to Dwg. ME-368229 and drawing below. ☑

Note(s):
Shims are to be installed ONLY on the TOPSIDE of the Chamber.

14.17 Once the gap is almost filled in, use the Feeler Gauge to determine the correct size of the last Shim. Use the Shim with the closest width to the measurement. ☑



Chamber Corner, Side View

Completed

14.18 Once the correct size Shims have been determined, record which size Shims were used on each corner in the chart below.

Chamber Corner Shims Used			
Wide End		**Narrow End**	
High Voltage Side	**Anode Side**	**High Voltage Side**	**Anode Side**
N/A	N/A	N/A	N/A

Bill Vandergriff
Technician(s)

8-17-01
Date

14.19 Install the Narrow End Panel Skins (368071) into the Narrow End, on each side of the Z-Bracket. ☑

14.20 Attach the Side ~~Panel~~ Skin (368072) onto High Voltage Side. ☑

Technician(s)

8/17/01
Date

X 14

Fermi National Accelerator Laboratory
Technical Division

CMS - Muon Endcap
Endcap Muon Chamber (ME234/2)

Chamber SN: ME234/2-045 **Drawing No.:** ME-368220

Weight (Lbs):	700	**Metric Weight (KG):**	317.5
Length (In):	136.53	**Metric Length (CM):**	346.8
Width (In):	59.60	**Metric Width (CM):**	151.4
Height (In):	8.93	**Metric Height (CM):**	22.7
		Date Completed:	8/13/2001

Inspector ____ Date 8/16/01

14.24 Transport the Chamber to the Chamber Test and Training area.

Technician(s) ____ Date 8-16-01

15.0 Production Complete

XXX 15.1 Process Engineering verify that the CMS Chamber Assembly (5520-TR-333370) is accurate and complete. This shall include a review of all steps to ensure that all operations have been completed and signed off. Ensure that all Discrepancy Reports, Nonconformance Reports, Repair/Rework Forms, Deviation Index and dispositions have been reviewed by the Responsible Authority for conformance before being approved.

Comments:

Pamela Bhar
Process Engineering/Designee

9/7/01
Date

16.0 Proceed to the next major operation as required.

ORIGINAL

TD/ENGINEERING & FABRICATION

PARTS KIT REQUEST

IMPORTANT NOTES:
1) MAGNET NUMBER MUST BE FILLED IN.
2) ONLY ONE FORM PER MAGNET.
3) PARTS COORDINATOR OR DESIGNEE MUST SIGN THIS FORM.
4) MATERIAL CONTROL WILL ISSUE PARTS AND RECORD ROUTING NUMBER.
5) ANY QUANTITIES NOT AVAILABLE WILL HAVE COMMENTS RETURNED TO THE PARTS COORDINATOR FOR REVIEW.

RELEASED BY

MAGNET NUMBER: ME234/2-045

PRODUCTION SIGNATURE: T J Gardner **BADGE#** 4569

TODAYS DATE: 15-Jun-01

NEED DATE: 21-Jun-01

DELIVER TO MP 9

BUDGET CODE: EPK

ISSUE VERIFICATION

MATERIAL CONTROL SIGNATURE: [signature]

DATE ISSUED TO STOCKROOM: 6-15-01

THIS KIT LIST IS FOR

ME-368220	D	ME 234/2 Muon Chamber Final Assembly

PART NUMBER	REV	DESCRIPTION	REQUIRED QTY/ASS'Y		MATERIAL CONTROL — QTY FILLED OUT BY STOCK ROOM: ISSUED	ROUTE FORM	NOT AVAIL	FILLED OUT BY EXPEDITER: DATE AVAIL	COMMENTS TO PRODUCTION MANAGER	PROD VERIFY PART	SUPT. VERIFY PART
368005	A	Stud, Center Gap Bar, 5-40 UNC x 5.93"	4	EA	4	71286				✓	
368006	C	Nut, Center Gap Bar Stud, 5-40 UNC	8	EA	8	74029				✓	
368008	C	Upper Gas Flow Tube	1	EA	1	74462				✓	
368009	B	Lower Gas Flow Tube	1	EA	1	74463				✓	
368012	A	Mounting Plate	5	EA	5	73612				✓	
368013	A	Label	2	EA	PROCESS ENG. TO PROVIDE						
368015		Screw, Pan Head Phillips, stainless 6-32UNC x 3/8"	10	EA	10	69885				✓	
368020	A	O-Ring, SilC Rub., 9/16"ID x 3/4" OD	284	EA	284	72906				✓	
368022	A	Bulkhead Connector, male M4 PT to 1/4" tube	2	EA	2	71186				✓	
368027		Nylon Cable Tie	6	EA	6	69615				✓	
368033	A	Test Strip Connector Label	1	EA	1	70061				✓	
368034	A	RTV Rubber & Catalyst RTV 9811	A/R								
368054		Insulation Tubing,Mylar,Heat Shrink	52	EA	52	70593				✓	
368097	A	Connector- Adapter	6	EA	6	73606				✓	
368099	A	Test Strip Cable Assembly	6	EA	6	75512				✓	
368101		Grounding Strip 6.00" x 2.75"	17	EA	17	70718				✓	
368102	D	Cable Assembly, High Voltage	1	EA	1	75770				✓	
368107		Grounding Strip 6.00x1.90	5	EA	5	69962				✓	
368116		Street Elbow	2	EA	2	72322				✓	
368117	A	Connector- Adapter	2	EA	2	72621				✓	
368119		Cap Plug	2	EA	2	72022				✓	
368221	D	Anode Panel Assembly	MP 9	HAS							
368222	D	Upper Cathode Panel Assy	MP 9	HAS							

RETURN THIS COMPLETED PARTS KIT REQUEST WITH THE ISSUED PARTS TO THE PARTS COORDINATOR.

[signature] 6/27/01 : STOCKROOM SIGNATURE AND DATE

TRAVELER NO. TR-XXXXXX

KIT IS COMPLETE (PARTS COORDINATOR SIGNATURE): [signature] BADGE # 4569

DATE 27 JUN 01

TD/ENGINEERING & FABRICATION

PARTS KIT REQUEST

ORIGINAL

IMPORTANT NOTES:
1) MAGNET NUMBER MUST BE FILLED IN.
2) ONLY ONE FORM PER MAGNET.
3) PARTS COORDINATOR OR DESIGNEE MUST SIGN THIS FORM.
4) MATERIAL CONTROL WILL ISSUE PARTS AND RECORD ROUTING NUMBER.
5) ANY QUANTITIES NOT AVAILABLE WILL HAVE COMMENTS RETURNED TO THE PARTS COORDINATOR FOR REVIEW.

RELEASED BY

MAGNET NUMBER: ME234/2-045

PRODUCTION SIGNATURE: T J Gardner **BADGE#** 4569

TODAYS DATE: 15-Jun-01

NEED DATE: 21-Jun-01

DELIVER TO MP 9

BUDGET CODE: EPK

ISSUE VERIFICATION

MATERIAL CONTROL SIGNATURE: [signature]

DATE ISSUED TO STOCKROOM: 6-15-01

THIS KIT LIST IS FOR

ME-368220	D	ME 234/2 Muon Chamber Final Assembly

PART NUMBER	REV	DESCRIPTION	REQUIRED QTY/ASS'Y		MATERIAL CONTROL: QTY FILLED OUT BY STOCK ROOM: ISSUED	ROUTE FORM	NOT AVAIL	FILLED OUT BY EXPEDITER: DATE AVAIL	COMMENTS TO PRODUCTION MANAGER	PROD VERIFY PART	SUPT. VERIFY PART
368223	E	Inner Cathode Panel Assy	MP 9	HAS							
368224	B	Lower Cathode Panel Assy	MP 9	HAS							
368261	A	Nut	2	EA	2	70189				—	—
368291		Almit Solder	A/R								
368328	A	Pan Head Screw	10	EA	10	70721				—	—
368523	A	Cable Connector Mounting Block	1	EA	1	74334				—	—
368524	A	Cable Connector Cover	1	EA	1	74335				—	—
368525		Screw, Pan Head	4	EA	4	74310				—	—
368526	A	Grommet	1	EA	1	74621				—	—
368529	A	Channel Sub-Assembly	1	EA	1	75412				—	—
368530		Pushbutton Switch	1	EA	1	73216				—	—
368675		Insulating Strips	5	EA	5	78511				—	—

RETURN THIS COMPLETED PARTS KIT REQUEST WITH THE ISSUED PARTS TO THE PARTS COORDINATOR.

[signature] 6/27/01 : STOCKROOM SIGNATURE AND DATE

TRAVELER NO. TR-XXXXXX

KIT IS COMPLETE (PARTS COORDINATOR SIGNATURE): [signature] BADGE # 4569

DATE 27JUN01

ORI AL

TD/ENGINEERING & FABRICATION

PARTS KIT REQUEST

IMPORTANT NOTES:
1) MAGNET NUMBER MUST BE FILLED IN.
2) ONLY ONE FORM PER MAGNET.
3) PARTS COORDINATOR OR DESIGNEE MUST SIGN THIS FORM.
4) MATERIAL CONTROL WILL ISSUE PARTS AND RECORD ROUTING NUMBER.
5) ANY QUANTITIES NOT AVAILABLE WILL HAVE COMMENTS RETURNED TO THE PARTS COORDINATOR FOR REVIEW.

RELEASED BY

MAGNET NUMBER: ME234/2-045

PRODUCTION SIGNATURE: T J Gardner **BADGE#** 4569

TODAYS DATE: 15-Jun-01

NEED DATE: 21-Jun-01

DELIVER TO ____________ **MP 9**

BUDGET CODE: EPK

ISSUE VERIFICATION

MATERIAL CONTROL SIGNATURE:

DATE ISSUED TO STOCKROOM: 6-15-01

THIS KIT LIST IS FOR

ME-368229	E	ME 234/2 Muon Chamber Frame Assembly

			REQUIRED		MATERIAL CONTROL: QTY FILLED OUT BY STOCK ROOM			FILLED OUT BY EXPEDITER		PROD	SUPT.
PART NUMBER	REV	DESCRIPTION	QTY/ASS'Y		ISSUED	ROUTE FORM	NOT AVAIL	DATE AVAIL	COMMENTS TO PRODUCTION MANAGER	VERIFY PART	VERIFY PART
368010	B	Washer, flat M10 x 30mm OD	6	EA	6	73192					
368011	C	Alignment pin	2	EA	2	72361					
368018	A	Ring, Retaining, External Diameter .38	2	EA	2	73195					
368039		Nut, Hex M10-1.5 DIN 4398	94	EA	94	73314					
368043	B	Mounting Bracket YZ Fixed Top	1	EA	1						
368044	B	Mounting Bracket Z Fixed Top	1	EA	1						
368045	B	Mounting Bracket XYZ Fixed Top	1	EA	1						
368046	A	Washer, Lock, Toothed	24	EA	24	71219					
368051	C	Panel Bolt "C"	6	EA	6	71220					
368052	C	Panel Bolt "B"	6	EA	6	71221					
368053	C	Panel Bolt "A"	32	EA	32	74087					
368055	A	Nut, Jam, SS 3/8-24-UNF	2	EA	2	73193					
368056	A	Washer, Flat, 3/8" AN960C SS	18	EA	18	72378					
368058	B	Bracket, Mounting YZ Fixed 5185C197	1	EA	1	74287					
368059	B	Bracket, Mounting Z Fixed 5185C198	1	EA	1	74331					
368060	C	Bracket, Mounting XYZ Fixed 5185C199	1	EA	1	74284					
368061	E	Extrusion, Top Small End 5185D255	1	EA	1	74503					
368062	E	Extrusion, Bottom Small End 5185D108	1	EA	1	74504					
368064	E	Side, Notched Bottom 5185E110	1	EA	1	74639					
368066	E	Side, Non-Notched Bpttom 5185E112	1	EA	1	74640					
368067	E ~~D~~	Extrusion, Top Big End 5185D226	1	EA	1	74396					
368068	F	Extrusion, Bottom Big End 5185D114	1	EA	1	74432					

RETURN THIS COMPLETED PARTS KIT REQUEST WITH THE ISSUED PARTS TO THE PARTS COORDINATOR.

6/27/01 : STOCKROOM SIGNATURE AND DATE

TRAVELER NO. TR-XXXXXX

KIT IS COMPLETE (PARTS COORDINATOR SIGNATURE): ____________ BADGE # 4529

DATE 27JUN01

TD/ENGINEERING & FABRICATION

PARTS KIT REQUEST

ORIGINAL

IMPORTANT NOTES:
1) MAGNET NUMBER MUST BE FILLED IN.
2) ONLY ONE FORM PER MAGNET.
3) PARTS COORDINATOR OR DESIGNEE MUST SIGN THIS FORM.
4) MATERIAL CONTROL WILL ISSUE PARTS AND RECORD ROUTING NUMBER.
5) ANY QUANTITIES NOT AVAILABLE WILL HAVE COMMENTS RETURNED TO THE PARTS COORDINATOR FOR REVIEW.

RELEASED BY

MAGNET NUMBER: ME234/2-045

PRODUCTION SIGNATURE: T J Gardner BADGE# 4569

TODAYS DATE: 15-Jun-01

NEED DATE: 21-Jun-01

DELIVER TO ____________ MP 9

BUDGET CODE: EPK

ISSUE VERIFICATION

MATERIAL CONTROL SIGNATURE: [signature]

DATE ISSUED TO STOCKROOM: 6-15-01

THIS KIT LIST IS FOR

ME-368229	E	ME 234/2 Muon Chamber Frame Assembly

PART NUMBER	REV	DESCRIPTION	REQUIRED QTY/ASS'Y		MATERIAL: QTY FILLED OUT BY STOCK ROOM: ISSUED	ROUTE FORM	NOT AVAIL	CONTROL: FILLED OUT BY EXPEDITER: DATE AVAIL	COMMENTS TO PRODUCTION MANAGER	PROD VERIFY PART	SUPT. VERIFY PART
368069	A	Screw, Thrd Forming M6-1 x 10	96	EA	96	71239					
368070	A	Washer, Lock, Toothed, Ext or Int	96	EA	96	71600					
368071	B	End Panel, Small 5185B115	2	EA	2	73490					
368072	B	Side Panel, 5185B116	1	EA	1	74[illegible]82					
368073	B	End Panel, Big 5185B118	1	EA	1	72337					
368074	C	End Plate, Big 5185B211	2	EA	2	74421					
368075	B	End Plate, Small 5185B212	2	EA	2	74086					
368076	A	Screw, Thd Forming M6-1 x 16	30	EA	30	71247					
368077	A	Screw, F. Hd Cap M6-1 x 12 mm	6	EA	6	71248					
368079	C	Plate, Stiffening, P2 5185C164	4	EA	4	73471					
368080		Shim, Light, 2 Slot 5185B228	2	EA	2	72364					
368081		Shim, Medium, 2 Slot 5185B228	2	EA	2	72365					
368082		Shim, Heavy, 2 Slot 5185b228	4	EA	4	72367					
368083		Shim, Light, 3 Slot 5185C229	1	EA	1	73938					
368084		Shim, Medium, 3 Slot 5185C229	1	EA	1	73987					
368085		Shim, Heavy, 3 Slot 5185C229	2	EA	2	73936					
368105	C	Panel Side, Anode El.	1	EA	1	74081					
368106	A	E-Ring	6	EA	6	71256					
368167	B	Extrusion, Top Anode Side	1	EA	1	74813					
368168	C	Extrusion, Top HV Side	1	EA	1	74639					
368303	A	Corner Shim, Light	2	EA	2	71257					
368306	A	Corner Shim, Medium	2	EA	2	72373					
368309	A	Corner Shim, Heavy	6	EA	6	72374					

RETURN THIS COMPLETED PARTS KIT REQUEST WITH THE ISSUED PARTS TO THE PARTS COORDINATOR.

[signature] 6/27/01 : STOCKROOM SIGNATURE AND DATE

TRAVELER NO. TR-XXXXXX

KIT IS COMPLETE (PARTS COORDINATOR SIGNATURE): [signature] BADGE # 4569

DATE 27 JUN 01

Fermi National Accelerator Laboratory
Batavia, IL 60510

CMS ME234/2 MUON CHAMBER ASSEMBLY TRAVELER

Reference Drawing(s)

Endcap Muon Chamber ME234/2 Final Assembly
5520-ME-368220

Endcap Muon Chamber ME234/2 Frame Assembly
5520-ME-368229

Magnet/Device Series: ME234/2	
Budget Code:	**Project Code:**
Released by: Pamela Klen	**Date:** NOV 14 2001
Date Closed: 1/11/02	**Scan Pages:** 38
Prepared by: B. Jensen, M. Hubbard, L. Lee, P. Isham	

Title	Signature	Date
TD / E&F Process Engineering	Bob Jensen / Bob Jensen/Designee	11/8/01
TD / E&F CMS Assembly	Glenn Smith / Glenn Smith/Designee	11/08/01
TD / E&F Technological Physicist	Oleg Prokofiev/Designee	11/08/01
TD / E&F CMS Project Manager	Apollinari / Giorgio Apollinari/Designee	11/08/01

Revision Page

Revision	Step No.	Revision Description	TRR No.	Date
None	N/A	Initial Release	N/A	6/20/00
A	5.7	Added Step 5.7	0990	7/07/00
	8.6, 8.7	Added Steps 8.6 and 8.7		
	12.22	Added Step 12.22 and drawing		
B	---	Removed the step measuring the thickness of the Chamber with the frame.	1069	10/09/00
	6.0	Added Section 6.0, "Chamber Cathode Strip Resistance Test."		
	7.0	Added Section 7.0,"Chamber Anode Wire Group Capacitance Measurements."		
	8.2.1	Added Part Numbers for Pneumatic Dispenser, Dispensing Cartridge, Mixing Nozzle, and Dispensing Needle.		
	13.12	Corrected the torque spec for the Alignment Pin Jam Nuts.		
C	4.6,4.13	Removed Lead Person signature line.	1084	11/28/00
	4.19,4.25	Removed Lead Person signature line.		
	4.31,4.37	Removed Lead Person signature line.		
	4.41	Removed Lead Person signature line.		
	5.11	Moved the installation of the LEMO Connectors from Step 11.1		
	5.17,5.26	Changed the torque value to 25 inch pounds.		
	6.2	Added a new step and drawing.		
	6.3	Added 51-Ohm Resistor Test.		
	7.1-7.4	Added Range Low-High values.		
	8.0	Added the Chamber High Voltage Test in Air.		
D	7.4	Changed the range on protection board #8 to 200/220, for channel number 16.	1114	02/06/01
	14.5	Added step 14.5		
E	7.1	Remove the protection board chart	1131	3/6/01
	7.2-7.4	Remove sections 7.2-7.4 "chamber anode wire group capacitance measurement"		
	7.1.1-7.1.8	Added protection board measure "PASS or FAIL"		
	7.2	Added attach chamber anode wire group capacitance measurement report to traveler		
	7.2.1	Added record number of pages in report		
F	14.22	Added connect AFEB Alignment Gages to Anode Side Panel, and a diagram and a chart.	1142	4/4/01
	10.16, 10.18	Added log pressure and flow rate at 1, 2, and 3 inches twice at intervals of 10 min.		
	10.17 10.19	Added new pressure of 2 and 3 inches is achieved.		
	10.20	Added log pressure and flow rate at 3 inches twice at intervals of 10 min. and line 6 to the chart.		
	10.21	Added 3 inches of pressure.		
G	14.0	Added 14.0 HV cable assembly	1146	4/24/01

Revision Page

Revision	Step No.	Revision Description	TRR No.	Date
H	4.11	Added alignment pins installation and removal.	1173	5/30/01
	4.12	Remove step 4.12.		
	4.16,4.28 4.35,4.40	Added temporary spacers and removal of alignment pins.		
	4.23	Changed alignment pins to temporary spacers.		
	4.24	Added remove alignment pins.		
	10.14-10.24	Changed and Added to leak test.		
	14.12	Added step 14.12.		
	17.0	Removed step and signature line.		
I	10.20	Added to notes to proceed to step 11.0 if leak test passed	1190	6/27/01
	11.1-11.3	Removed steps 11.1-11.3		
	11.4-11.7	Moved steps 11.4 -11.7 to 10.23		
	11.8	Removed step 11.8		
	15.19, 15.22	Removed steps 15.19 and 15.22		
	7.1	Removed "(LCR Meter)"		
J		See Attached Traveler with changes in red ink.	1225	8/20/01
K	14.0	Removed step 14.0, Chamber final. It was moved to the Chamber Elec. And HV test traveler.	1240	10/3/01
L	CVRPG	Added magnet device, date closed, scanned pages to the cover sheet, and serial number prefix to the bottom of the cover sheet.	1275	10/24/01
	5.10	Move 5.10 to 5.18.		
	5.16	Removed the side panels and end plates that's in parenthesis		
	5.17	Added step 5.17 perform a HV test.		
	7.0-7.2.1	Moved to step 8.0-8.2.1.		
	8.0-8.9	Moved to step 7.0-7.9.		
	13.14	Move steps 13.14 to Chamber Electrical Traveler 333255.		
	13.15	Removed step 13.15.		
M	CVRPG	Added serial number prefix.	1286	11/8/01
	5.9	Added a note to step 5.9, place red cap plug on gas connectors.		

Ensure appropriate memos and specific instructions are placed with the traveler before issuing the sub traveler binder to production.

1.0 General Notes

1.1 White (Lint Free) Gloves (Fermi stock 2250-1800) or Nitrile Gloves (Fermi stock 2250-2040) shall be worn by all personnel when handling all product parts after the parts have been prepared/cleaned.

1.2 All steps that require a sign-off shall include the Technician/Inspectors first initial and full last name.

1.3 No erasures or white out or pencil or markers will be permitted to any documentation. All incorrectly entered data shall be corrected by placing a single line through the error, initial and date the error before adding the correct data.

1.4 All Discrepancy Reports issued shall be recorded in the left margin next to the applicable step.

1.5 All personnel performing steps in this traveler must have documented training for this traveler and associated operating procedures.

1.6 Personnel shall perform all tasks in accordance with current applicable ES&H guidelines and those specified within the step.

1.7 Cover the product/assembly with Mylar when not being serviced or assembled.

2.0 Parts Kit List

2.1 Attach the completed Parts Kit for this production operation to this traveler. Ensure that the serial number on the Parts Kit matches the serial number of this traveler. Verify that the Parts Kit received is complete.

Pamela Fisher — NOV 14 2001

Process Engineering/Designee — Date

3.0 Panel Selection

Completed

3.1 Select the required panels and ensure there are the correct quantity of each according to the chart below. ☑

Panel Location	Panel Designation	
Cathode Upper	ME234/2-UC-	115
Anode	ME234/2-A-	344
Cathode Inner	ME234/2-IC-	228
Anode	ME234/2-A-	311
Cathode Inner	ME234/2-IC-	229
Anode	ME234/2-A-	340
Cathode Lower	ME234/2-LC-	112

Kerry A. Dees
Technician(s)

12-12-01
Date

4.0 Panel Stacking/Assembly

4.1 Clean the Chamber Assembly Table with Ethyl Alcohol (Fermi Stk. No. #1920-0600) and a low lint wipe (Fermi Stk No. 1660-2500) to ensure the table is free of dirt, dust, oil and debris. ☑

4.2 Count out and clean EXACTLY 284 O-rings (368020) and place them in the Assembly Clean Room prior to stack up of panels. ☑

4.3 Clean the Cathode Lower Panel (both sides) with Ethyl Alcohol (Fermi Stk. No. #1920-0600) and a low lint wipe (Fermi Stk No. 1660-2500) and stage it onto the Chamber Assembly Table. ☑

4.4 Blow the Cathode Lower Panel off with Ionized air. ☑

4.5 Install and verify that all the O-rings (368020) are seated flat into their respective counterbores. ☑

4.6 Record the Serial number of the Lower Cathode Panel onto the chart after step 4.42. ☑

Kerry A. Dees
Technician(s)

12-12-01
Date

Completed

4.7 Acquire the first Anode Panel and transport it to the Ionization Cleaning Station. Install Spacer Bars (368248) onto each side of the panel before performing the Air Knife procedure. ☑

4.8 Clean the first Anode Panel according to the Air Knife Operating Procedure. ☑

4.9 Inspect each hole and crevice to be sure it is clean and there is no debris, oil, dirt or particles and ensure the wires are free from any debris. ☑

4.10 Transport the first Anode Panel from the Ionization Cleaning station to the Chamber Assembly Table. Remove the Anode Panel from the transport cart and using temporary spacers between the panels to allow room for removal of the cart hardware, install the Anode Panel on top of the Cathode Lower Panel with the screw head of the cart hardware facing up and the Strip Side of the panel facing down. ☑

Note(s):

Ensure the O-rings remain in place as the Anode Panel is lowered over the Cathode Panel.

4.11 Remove the transport cart hardware. Install the two temporary 12" long alignment pins into the alignments holes, and then remove the temporary spacers from the Lower Cathode Panel. Lower the Anode Panel onto the Lower Cathode Panel pushing it down flat onto the Cathode Panel Gap Bars. Remove the alignment pins from the alignment holes. ☑

4.12 Record the Serial number of the first Anode Panel onto the chart after step 4.42. ☑

Kerry Cawes
Technician(s)

12-12-01
Date

4.13 Clean the Strip Side of a Cathode Inner Panel with Ethyl Alcohol (Fermi Stk. No. #1920-0600)and a low lint wipe (Fermi Stk No. 1660-2500), and blow both it off with Ionized air. ☑

4.14 Install and verify that all the O-rings (368020) are seated flat into there respective counter bores on the Strip Side of the panel. ☑

4.15 Lower the Inner Cathode Panel with the Strip Side facing down, onto the temporary spacers over the Anode Panel on the assembly table. Ensuring all O-rings are present and in proper position. Install the temporary alignment pins into the alignment holes, and then remove the temporary spacers from the Anode Panel and lower Cathode Panel into place. Remove the alignment pins from the alignment holes. ☑

Note(s):

Ensure the alignment pins remain perpendicular to the Panels.

Completed

4.16 Clean the Non-Strip Side of the Cathode Inner Panel with Ethyl Alcohol (Fermi Stk. No. #1920-0600)and a low lint wipe (Fermi Stk No. 1660-2500), and blow both it off with Ionized air. ☑

4.17 Install and verify that all the O-rings (368020) are seated flat into there respective counter bores on the Non-Strip Side of the panel. ☑

4.18 Record the Serial number of the Inner Cathode Panel onto the chart after step 4.42. ☑

Kerry Cavers
Technician(s)

12-12-01
Date

4.19 Acquire the second Anode Panel and transport it to the Ionization Cleaning Station. Install Spacer Bars (368248) onto each side of the panel before performing the Air Knife procedure. ☑

4.20 Clean the second Anode Panel according to the Air Knife Operating Procedure. ☑

4.21 Inspect each hole and crevice to be sure it is clean and there is no debris, oil, dirt or particles and ensure the wires are free from any debris. ☑

4.22 Transport the second Anode Panel from the Ionization Cleaning station to the Chamber Assembly Table. Remove the Anode Panel from the transport cart and using temporary spacers between the second Anode Panel and the Inner Cathode Panel to allow room for removal of the cart hardware, install the Anode Panel onto the temporary spacers on top of the Cathode Inner Panel with the screw head of the cart hardware facing up and the Strip Side of the panel facing down. ☑

Note(s):

Ensure the O-rings remain in place as the Anode Panel is lowered over the Cathode Panel.

4.23 Remove the transport cart hardware and then the temporary spacers from the Inner Cathode Panel and lower the Anode Panel flush onto the Inner Cathode ensuring the O-rings stay in place, pushing it down flat onto the Cathode Panel Gap Bars. Remove the alignment pins from the alignment holes. ☑

Note(s):

Ensure the alignment pins remain perpendicular to the Panels.

4.24 Record the Serial number of the second Anode Panel onto the chart after step 4.42. ☑

Kerry Cavers
Technician(s)

12-12-01
Date

Completed

4.25 Clean the Strip Side of a Cathode Inner Panel with Ethyl Alcohol (Fermi Stk. No. #1920-0600)and a low lint wipe (Fermi Stk No. 1660-2500), and blow both it off with Ionized air. ☑

4.26 Install and verify that all the O-rings (368020) are seated flat into there respective counter bores on the Strip Side of the panel. ☑

4.27 Lower the Inner Cathode Panel with the Strip Side facing down, onto the temporary spacers and over the Anode Panel on the assembly table ensuring all O-rings are present and in proper position. Install the temporary alignment pins into the alignment holes. Remove the temporary spacers from the Anode Panel, and lower the panel into place. Remove the alignment pins from the alignment holes. ☑

Note(s):

Ensure the alignment pins remain perpendicular to the Panels.

4.28 Clean the Non-Strip Side of the Cathode Inner Panel with Ethyl Alcohol (Fermi Stk. No. #1920-0600)and a low lint wipe (Fermi Stk No. 1660-2500), and blow both it off with Ionized air. ☑

4.29 Install and verify that all the O-rings (368020) are seated flat into there respective counter bores on the Non-Strip Side of the panel. ☑

4.30 Record the Serial number of the Inner Cathode Panel onto the chart after step 4.42. ☑

Kerry Glass 12-12-01
Technician(s) Date

4.31 Acquire the third Anode Panel and transport it to the Ionization Cleaning Station. Install Spacer Bars (368248) onto each side of the panel before performing the Air Knife procedure. ☑

4.32 Clean the third Anode Panel according to the Air Knife Operating Procedure. ☑

4.33 Inspect each hole and crevice to be sure it is clean and there is no debris, oil, dirt or particles and ensure the wires are free from any debris. ☑

4.34 Transport the third Anode Panel from the Ionization Cleaning station to the Chamber Assembly Table. Remove the Anode Panel from the transport cart and using temporary spacers between the third Anode Panel and the Inner Cathode Panel to allow room for removal of the cart hardware, install the Anode panel onto the temporary spacers on top of the Cathode Inner Panel with the screw head of the cart hardware facing up and the Strip Side of the panel facing down. ☑

Note(s):

Ensure the O-rings remain in place as the Anode Panel is lowered over the Cathode Panel.

Completed

4.35 Remove the transport cart hardware and then the temporary spacers from the Inner Cathode Panel and lower the Anode Panel flush onto the Inner Cathode ensuring the O-rings stay in place, pushing it down flat onto the Cathode Panel Gap Bars. Remove the alignment pins from the alignment holes. ☑

Note(s):

Ensure the alignment pins remain perpendicular to the Panels.

4.36 Record the Serial number of the third Anode Panel onto the chart after step 4.42. ☑

Kerry Cavers ____ 12-12-01 ____
Technician(s) Date

4.37 Clean the Cathode Upper Panel (both sides) with Ethyl Alcohol (Fermi Stk. No. #1920-0600)and a low lint wipe (Fermi Stk No. 1660-2500). Blow the panel off with Ionized air. ☑

4.38 Install and verify that all the O-rings (368020) are seated flat into there respective counter bores. ☑

4.39 Lower the Upper Cathode Panel with the Gap Bar side facing down onto the temporary spacers and over the Anode Panel on the assembly table ensuring all O-rings are present and in proper position. Install the alignment pins in the alignment holes, and then remove the temporary spacers from the Anode Panel. Lower the Upper Cathode into place. ☑

Note(s):

Ensure the alignment pins remain perpendicular to the Panels.

4.40 Record the Serial number of the Upper Cathode Panel onto the chart after step 4.42. ☑

Kerry Cavers ____ 12-12 01 ____
Technician(s) Date

4.41 Remove the two 12" long temporary alignment pins and install the two Alignment Pins (368011), one through the narrow end and one through the wide end of the panels.

Note(s):

Ensure the ring grooved end of the pins are inserted first down through the Upper Cathode Panel alignment holes.

Kerry Ch... 12-12-01

Technician(s) Date

Panel Location	Panel Designation	Panel Serial No.#
Cathode Upper	ME234/2-UC-	115
Anode	ME234/2-A-	344
Cathode Inner	ME234/2-IC-	228
Anode	ME234/2-A-	311
Cathode Inner	ME234/2-IC-	229
Anode	ME234/2-A-	340
Cathode Lower	ME234/2-LC-	112

X 4.42 Ensure all panel serial numbers have been correctly recorded in the chart above.

D. Battistella 12-12-01

Lead Person Date

5.0 Chamber Framework Installation

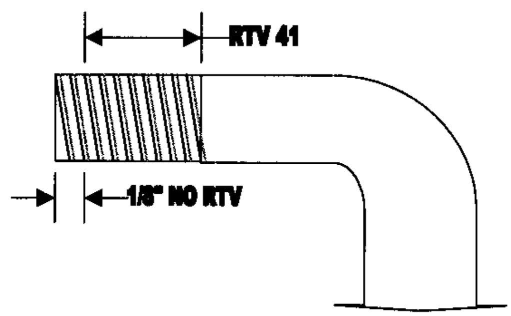
Completed

5.1 Clean all the parts of the framework with Ethyl Alcohol (Fermi Stk. No. #1920-0600) and low lint wipes (Fermi Stk No. 1660-2500). ☑

5.2 Cover all assembly bolts with Shrink Mylar Insulation Tubing and using the heat gun to shrink the Mylar down over the bolts minimizing bunching and wrinkles in the Mylar. ☑

5.3 Install appropriate bolts (368051 and 368053) through all the wide end panel assembly holes taking care NOT to tear the Mylar insulation. ☑

5.4 Apply a bead of RTV41 to the threads on Gas Tubes (368008 and 368009) as shown below, and install Tubes into the appropriate threaded hole in the Upper and Lower Cathode Panels. ☑



Note(s):

Ensure NO RTV is on the first 1/8" of the thread.

5.5 The "U" type tube is on the right side of the chamber, and "Z" type tube on the left. Thread the tubes inward until torque increases significantly, then continue until open end of tube points vertically. ☑

5.6 Install the Bulkhead Connectors (368022) into the Upper Wide End Extrusion. ☑

5.7 Install the Gas Connector Elbows (368116) onto the Bulkhead Connectors. ☑

5.8 Install the top and bottom Wide End Extrusions (368067 and 368068) over the bolts onto the chamber and secure with nuts. ☑

Note(s):

ONLY HAND TIGHTEN the nuts onto the bolts.

5.9 Carefully connect the Gas Tubes into the Bulkhead Connectors ensuring to only hand tighten the connector nuts. ☑

Note(s):

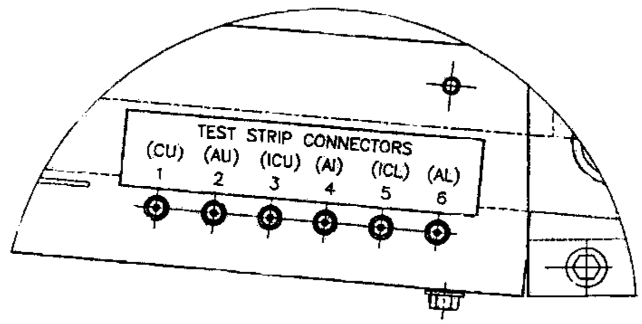
Place the red cap plugs (368119) over the gas connectors on the chamber to keep free of contaminants.

Kerry Wees
Technician(s)

12-12-01
Date

Completed

5.10 Install the LEMO Connectors (MA-368097 [6 ea.] into the top High Voltage side extrusion near the wide end. ☑



5.11 Install the High Voltage Side top and bottom extrusions (368065 and 368066) over the bolts onto the chamber and secure with nuts. ☑

Note(s):

ONLY HAND TIGHTEN the nuts onto the bolts.

5.12 Install the Anode Side top notched and bottom extrusions (368063 and 368064) over the bolts onto the chamber and secure with nuts. ☑

Note(s):

ONLY HAND TIGHTEN the nuts onto the bolts.

5.13 Install top and bottom Narrow End Extrusions (368061 and 368062) over the bolts onto the chamber and secure with nuts. ☑

Note(s):

ONLY HAND TIGHTEN the nuts onto the bolts.

5.14 Install the End Stiffening Plates on the Narrow end. ☑

5.15 Assemble the O-rings (368020) into the Brass Nuts (368006) and then assemble the nuts to the Assy. Studs (368005 and 368006) through the center holes of the panels. Hand tighten the nuts. ☑

X 5.16 Dry fit remaining Frame Assy. parts to ensure extrusions have been installed correctly. ☑

5.17 Install 3 bolts on the anode side and the high voltage side, and install 2 bolts on the narrow end and the wide end of the panel. Then perform a quick high voltage test on the chamber. ☑

Note(s):

ENSURE ALL REMAINING PARTS HAVE BEEN DRY FIT BEFORE CONTINUING ASSEMBLY OF CHAMBER!

Kenny Calhes
Technician(s)

12-12-01
Date

Completed

5.18 Install the remainder of the bolts around the perimeter of the chamber in the panel assembly holes taking care NOT to tear the Mylar insulation. ☒

Lead Person

Date 12-12-01

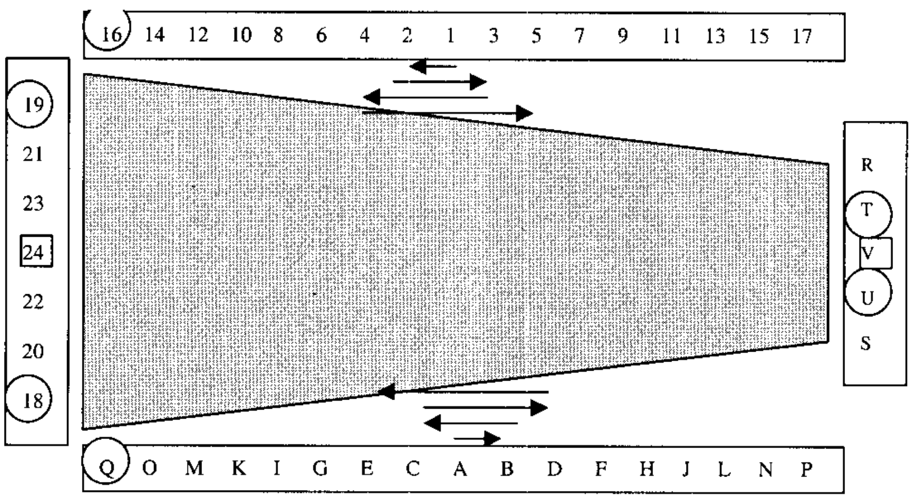
Note(s)

Tightening of Chamber Bolts is a process that requires two technicians.

5.19 Torque the Center Assy. Brass Studs to 25 inch pounds. ☒

5.20 Remove dry fit side panel and end plates before continuing.

5.21 With one Tech starting at the 9th bolt from the narrow end, High Voltage side (marked as position "1" on the drawing below) and the other Tech starting at the 9th bolt from the wide end on the Anode side (marked as position "A" on the drawing below), torque bolts "A-1" to 25 inch pounds. ☒



5.22 Each Tech then moves to his/her next successive bolt (from "1" to "2", and from "A" to "B") and torques it to 25 inch pounds. Continue to torque bolts to 25 inch pounds in sequential order (A-1, B-2, C-3…) until all bolts at torqued except the alignment bolts (square bolts 24 and V) in above diagram. ☒

5.23 Check to ensure 6 E-rings are in place, along with a Jam Nut before attempting to torque the Z-Bracket Bolts (those circled in above diagram). ☒

Note(s):

Do NOT attach Snap Rings or attempt to torque Alignment Bolts (24 and 'V' in squares above) at this time.

Completed

5.24 In the same manner and order as steps 5.18 and 5.19, torque all bolts to 45 inch pounds, EXCEPT Alignment bolts (those with a square in above diagram). ☑

5.25 In the same manner and order as step 5.21, torque all bolts to 55 inch pounds. ☑

5.26 Once Z-Bracket Bolts have been torqued to 55 Inch pounds, remove the Jam Nuts from the bottom of these bolts. ☑

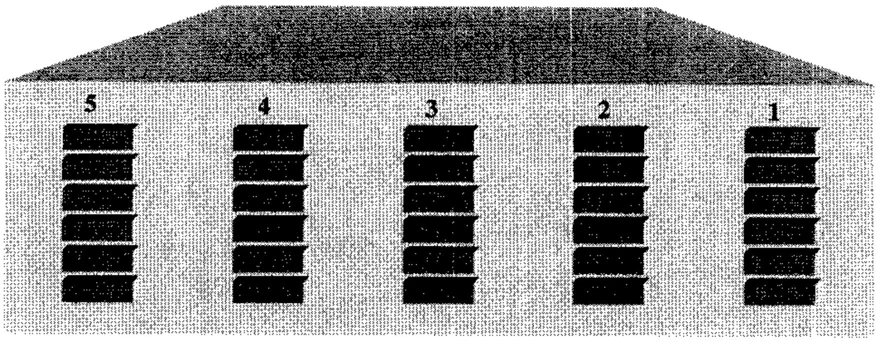
5.27 Re-torque ~~Center Assy.~~ Brass Studs to ensure they have remained at 25 inch pounds. ☑

M. Battisti 12-12-01

Technician(s) Date

6.0 Chamber Cathode Strip Resistance Test / 51 Ohm Resistor Check

6.1 Using a Multimeter, and a Toggle Switch Box, check the continuity in resistance of the cathode strip connectors. In accordance with the drawing, test each connector and if it passes, check it off in the chart below. If it fails, write the resistance value in the "Fail" box.



Plane # 1
Plane # 2
Plane # 3
Plane # 4
Plane # 5
Plane # 6

Note(s):

All measurements must be within the range of 0.9 – 1.1 Meg Ohm.

	5		**4**		**3**		**2**		**1**	
	Pass	**Fail**	**Pass**	**Fail**	**Pass**	**Fail**	**Pass**	**Fail**	**Pass**	**Fail**
Plane #1	X		X		X		X		X	
Plane #2	X		X		X		X		X	
Plane #3	X		X		X		X		X	
Plane #4	X		X		X		X		X	
Plane #5	X		X		X		X		X	
Plane #6	X		X		X		X		X	

Remarks:

Note(s):

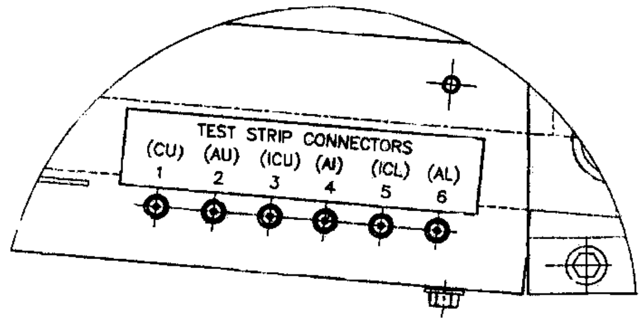
After measurements are completed inform supervisor of any failures.
If all pass continue.

Mark Calbeck
Technician(s)

12-12-01
Date

Completed ✓

6.2 Connect the six (6) Test Cable Assemblies (368099) to the six (6) LEMO Connectors near the wide end of the chamber.



6.3 Plug a Multimeter into each LEMO Connector separately to measure the resistor value of the 51Ohm resistors. Resistor value should read between 48 Ω to 54 Ω.

Resistor	Pass	Fail
Upper Cathode (CU)	X	
Anode (AU)	X	
Inner Cathode (ICU)	X	
Anode (AI)	X	
Inner Cathode (ICL)	X	
Anode (AL)	X	

Note(s):

After measurements are completed inform supervisor of any failures.
If all pass continue.

R. Battiste
Technician(s)

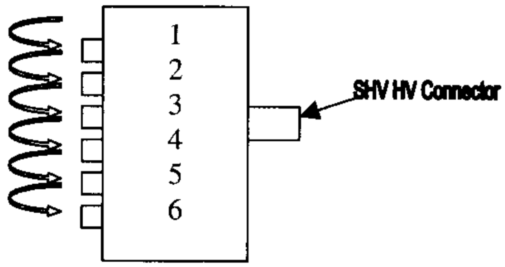
12-12-01
Date

7.0 Chamber High Voltage (HV) Electrical Test in Air

Completed

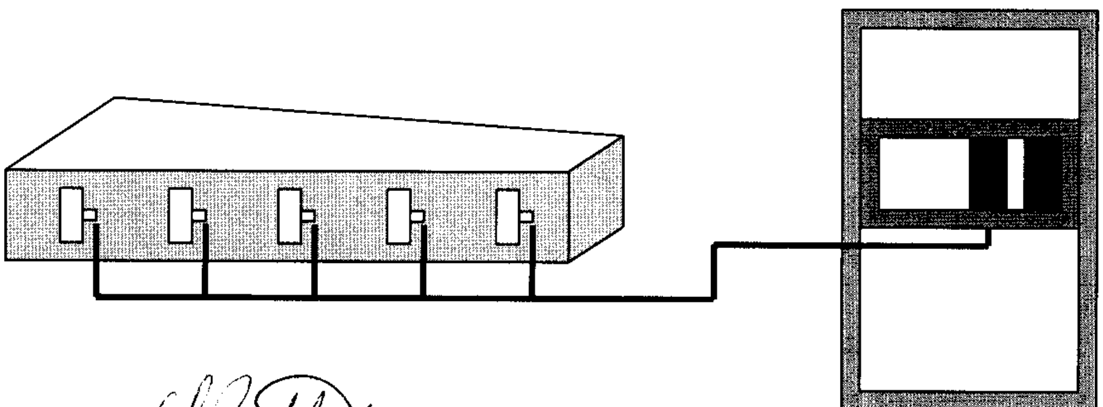
7.1 Attach the five (5) HV Glastic Channels to the Chamber. ☑

7.2 Connect the HV banana jumpers to the HV Glastic Channels. ☑



7.3 Connect together six (6) ground plugs (one from each plane) on the wide end of the Chamber. ☑

7.4 Connect the HV red cables from the HV power supply to the Glastic SHV HV Connectors.



Technician(s) ________________ Date 12.12.01

Completed

Note(s):
High Voltage Test should not be performed for longer than 30 minutes.

7.5 Slowly raise the High Voltage up to 3.8 kV (2-3 minutes per voltage step) and record the current data from the Chamber onto the Table below. ☑

	Chamber All Panels	Time		Segment #				
				1	2	3	4	5
HV KV	I µA	Start	Stop	I µA	I µA	I µA	I µA	I µA
1.0	M.B. ~~8~~.01	1:30	1:32					
2.0	MB ~~X~~0.10	1:32	1:34					
3.0	.30	1:34	1:36					
3.2	.40	1:36	1:38					
3.4	.60	1:38	1:40					
3.6	1.2	1:40	1:42					
3.7	2.0	1:42	1:44					
3.8	3.4	1:44	1:50	1.2	.2	.2	.2	16

7.6 When the Voltage is at 3.8 kV, record the current from each HV Segment onto the table. ☑

Note(s):
If Corona or a high current (more than 5 µA per HV Segment) occurs, make a note in the corresponding area above, disconnect that Segment and continue to raise the HV in accordance with the procedure.

Notify the supervisor if any discrepancy occurs.

7.7 When the HV test is complete, turn the High Voltage off SLOWLY. Wait until the HV drops to 30 volts (30mV on the voltmeter). ☑

7.8 Disconnect the red HV cables from the Chamber. ☑

7.9 Remove the HV Glastic Channels and place the screws back in the mounting plates. ☑

R. Balderas
Technician(s)

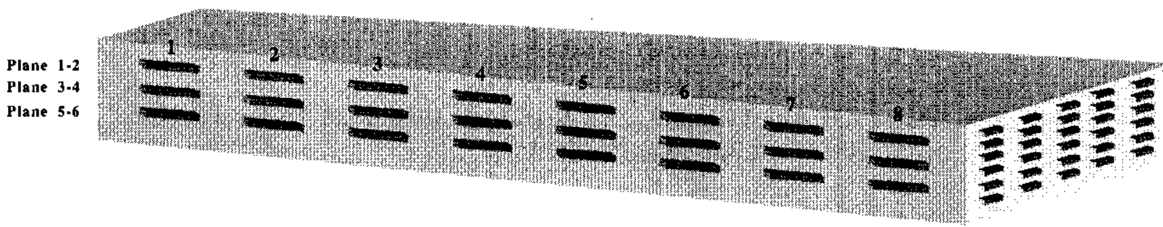
12-12-01
Date

8.0 Chamber Anode Wire Group Capacitance Measurements

8.1 Using a Capacitance Measuring Unit, measure the anode wire group capacitance from the protection boards. Begin measuring from the narrow side of Chamber.

Note(s):

After measurements are completed inform supervisor of any discrepancy with reference data table with the capacitance measurements.



		PASS	FAIL
8.1.1	Protection Board #1 measurement	☑	☐
8.1.2	Protection Board #2 measurement	☑	☐
8.1.3	Protection Board #3 measurement	☑	☐
8.1.4	Protection Board #4 measurement	☑	☐
8.1.5	Protection Board #5 measurement	☑	☐
8.1.6	Protection Board #6 measurement	☑	☐
8.1.7	Protection Board #7 measurement	☑	☐
8.1.8	Protection Board #8 measurement	☑	☐

8.2 Attach the chamber anode wire group capacitance measurement report to this traveler. ☑

8.2.1 Record the number of pages in the report 4.

Remarks:______________________________

Imre Pal
Technician(s)

12/17/01
Date

9.0 Chamber Sealing

Completed

9.1 Transport Chamber to appropriate Sealing Station (if different from Assembly Table). ☑

9.2 Prepare RTV dispensing equipment. ☑

9.2.1 Acquire Pneumatic Dispenser (368712), Dispensing Cartridge (368715), Mixing Nozzle (368717, 368718), and Dispensing Needle (368698). ☑

9.2.2 Fill the LARGE section of the Dispensing Cartridge with RTV 41, and fill the SMALL section with RTV 9811 Hardener. ☑

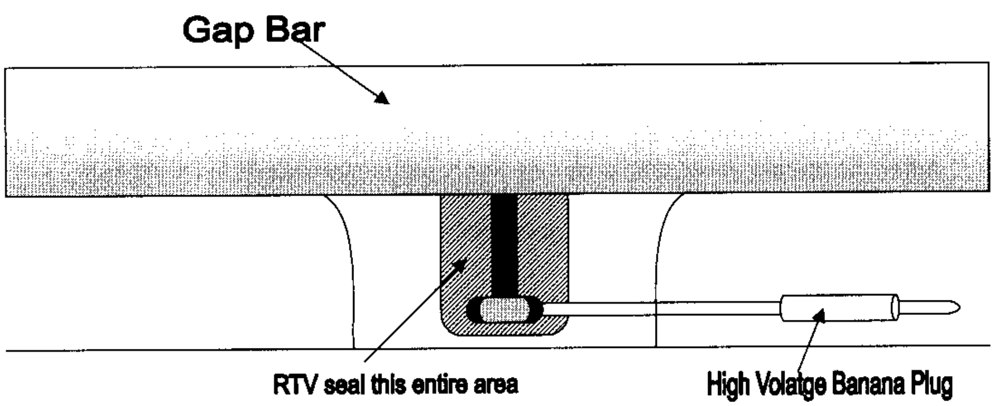
9.2.3 Into the Pneumatic Dispenser, place the Dispensing Cartridge, and then attach the Mixing Nozzle and Dispensing Needle. ☑

9.2.4 Hook up the Pneumatic Dispenser to House Air. ☑

9.3 Using Pneumatic Dispenser, seal the gaps between Anode Panels and Cathode Gap Bars along all panels. Apply approximately 1/8" fillet bead of RTV. Ensure RTV is applied behind all components, around all the corners and in all vertical gaps between Gap Bars. ☑

Note(s):

When sealing behind the HV Banana plug connector, completely cover the High Voltage Solder Joint and conductive pad as shown. Verify proper sealing with the RTV and eliminate any and all void areas. ☑



9.4 Allow the RTV to set up for 4 hours before continuing. ☑

9.5 Rotate Chamber 180°, so the Lower Cathode Panel is now on top. Seal all remaining gaps in a similar manner. ☑

9.6 Let the Chamber to sit for 24 hours to allow the RTV to cure. ☑

[signature] 12-13-01

Technician(s) Date

10.0 Leak Check (Digital Leak Rate System)

Completed

Note(s):

Never at any point during the test should the technician walk away. The Technician must pay close attention when the test is being preformed.

Every time this test is performed it should be performed at the same barometric pressure.

10.1 Set the Main Valve and Microcalibrator Valve to the closed/off position.

10.2 Turn on both the Microcalibrator Power Switch (Panel Front) and the Sen-I-Tran Power Switch (Back Panel).

10.3 Set the bottle pressure gauge regulator to 15psi.

10.4 Connect a clean dry Argon supply to gas input on the back panel of the Leak Measurement Device. Tighten the connections 1/8 turn past finger tight.

10.5 Open Argon bottle valve.

Note(s):

Ensure pressure gauge on Argon bottle reads 15psi.

10.6 Verify the System Pressure Gauge on the back panel reads 12 inches Water Column.

10.7 Turn the Main Valve to ON. Turn the Microcalibrator Valve to OPEN. Flow of gas through the Leak Measurement Device shall now occur.

10.8 Open the Flow Adjustment Valve (counter-clockwise) to allow the mechanical flowmeter to reach full scale (130 ccm). The Microcalibrator will give an error reading at this point since the actual flow exceeds its working range.

10.9 Turn down the flow rate to the point where the Microcalibrator is reading 10ccm. This procedure verifies that the delivery system is properly working and allows for purging of the Leak Measurement Device.

10.10 Turn the Main Valve to OFF.

10.11 Verify the Sen-I-Tran (Chamber Pressure) Gauge reads between –0.015 and +0.015 inches of water.

10.12 Connect the Test Ports (Chamber Pressure and Flow To Chamber) of the Leak Measurement Device to the Chamber Bulkhead Connectors. (It does NOT matter which tube is connected to which port)

10.13 Verify the Sen-I-Tran (Chamber Pressure) Gauge still reads between –0.015 and +0.015 inches of water.

Completed

10.14 Turn the Main Valve to begin the flow. The Microcalibrator should read 10ccm. To pressurize the chamber, increase the gas flow by turning the Flow Adjustment Valve until the mechanical flowmeter reads its full value of 130 ccm. The chamber pressure should immediately begin increasing. Within a 10-15 minutes the pressure should read 2.9 inches. When it does, reduce the flow rate gradually so that the target pressure of 3.00 inches is gradually approached ☑

10.15 Close the bottle, pressure regulator valve, and microcalibrator valve. ☑

10.16 Turn the main valve to gas flashing position to drop the pressure on the manometer to 0 (backside of LMD) and then turn main valve to close position. ☑

10.17 Wait for 5 minutes before starting the measurements. Using the weather station device for measurements of atmospheric pressure, temperature and humidity. ☑

10.18 Leak test the chamber for 16-24 hours. Record a few measurements at the beginning and at the end of the leak test measurements at intervals of 1-2 hours. Record data in the table below. ☑

#	Chamber Pressure (P) inch, Water	Barometric Pressure (B) inch, Hg	Temperature F°	Humidity %	Time T h/min	Date day
1	3.27	29.06	70.7	36%	8:50	12-14-01
2	3.97	29.09	71.6	34%	1:10 PM	12-14-01
3	3.85	29.12	72.5	35%	3:10 PM	12-14-01
4	4.79	29.03	70.7	34	10:00 AM	12-15-01
5						
6						
7						
8						
9						
10						

10.19 Calculate leak rate in accordance with the formula below.

$$\text{Leak rate (cm}^3\text{/min)} = \frac{3000\,(2\Delta P + 13.6\,\Delta B)}{(\Delta P_{final} + \Delta P_{initial})\ \Delta T}$$

Where: $\Delta P = P_{initial} - P_{final}$, chamber pressure in inch water,
$\Delta B = B_{initial} - B_{final}$, barometric pressure in inch Hg
$\Delta T = T_{final} - T_{initial}$, minutes,

10.20 Record result of the leak rate calculation in the table below.

Leak rate, cm^3/min	Date
-0.65	12-15-01

Note(s):

Leak Flow Rate MUST be less than $2.0cm^3$/min.
If chamber passes leak rate test proceed to step 11.0.

10.21 If leak rate is higher than 2.0cc/min start procedure for definition of lead location using a leak detector. Record results of leak investigation below.

Cause Of Leak: ____________________

10.22 When leak is fixed, repeat leak test measurements. Record a few measurements at the beginning and at the end of the leak test measurements at intervals of 1-2 hours. Record data in the table below.

10.23 Turn off the Sen-I-Tran Unit; disconnect the gas lines to the chamber. ❐
Install Cap-Plug (368119) over the gas connectors on the Chamber to keep it free of contaminants.
Zip tie the Compression Nuts (368117) to the Gas Connectors for safe transportation.

#	Chamber Pressure (P) inch, Water	Barometric Pressure (B) inch, Hg	Temperature F°	Humidity %	Time T h/min	Date day
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

Note(s):

Temperature must not be more than + – 2° Fahrenheit during measurements.

10.24 Calculate leak rate in accordance with formula (see 10.19). Record result of the leak rate calculation in the table below.

Leak rate, cm^3/min	Date

Note(s):

Leak Flow Rate MUST be less than 2.0cm^3/min.

Remarks:____________________

____________________ 12-15-01
Technician(s) Date

X 10.25 Verify all Section 10.0 steps have been properly completed and signed off and the panel is acceptable for further processing.

____________________ 12-15-01
Lead Person Date

11.0 High Voltage Chamber Wiring

Completed

11.1 Install Switchboard Terminal Channel (MA-368007 [5 ea.]) onto the High Voltage Chamber Side using Polycarbonate RHS Screws (MA-368328 [10 ea.]) and Mounting Plater (MA-368012) [5 ea]).

11.2 Install Switchboard Terminal (MA-368021 [18 ea]) onto Switchboard Terminal Channel.

11.3 Install the HV cable assembly (MA-368102 [1 ea.]) using screws M5 X 1" Thread Forming Screws (MA-368075) (supplied with chamber frame) along the length of the chamber.

11.4 Secure the HV cable to the chamber using cable ties (MA-368027 [1 ea]) and cable ties (MA-368027 [6 ea]). Remove excess wire tie ends by cutting with approved cutters.

11.5 Plug in HV Banana Plug Assy's into the Switchboard Terminals.

Technician(s) 12-15-01
Date

12.0 Soldering Foil

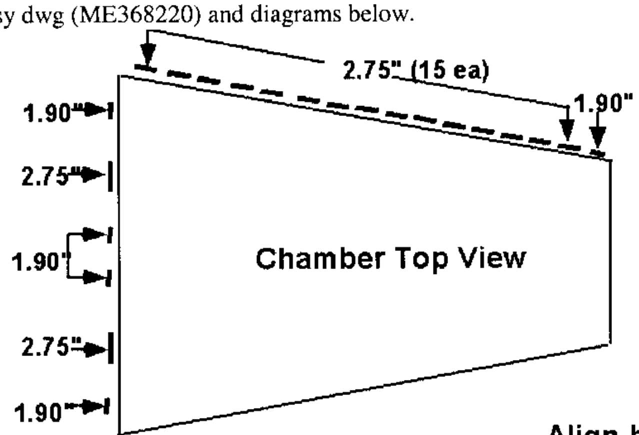
Completed

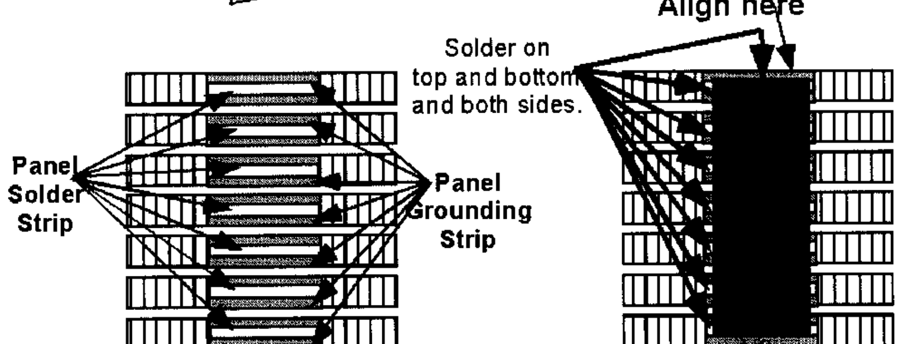
Note(s):

To install the Chamber Grounding Strips (MA-368107 & MA-368101), place the Strips on top of the panel grounding strips and solder in the correct locations in accordance with ME234/2 Chamber Final Assy dwg (ME-368220). Ensure prior to installing the Chamber Grounding Strips, that all the Panel Grounding Strips have a solder strip. Place the Chamber Grounding Strip onto the Upper Cathode Panel aligning to center of the solder strip and solder. Solder the Chamber Grounding Strip to all the other panels working from top to bottom. Solder must hold down the edge of the Chamber Grounding Strips to the Panel Grounding Strips. While soldering the Chamber Grounding Strip to other panels, keep the Chamber Grounding Strip tight and free of wrinkles, bumps and other imperfections.

12.1 Install 5 ea Grounding Strips 6.00 x 1.90" (MA-368107) onto the Chamber as per Final Assy dwg (ME-368220) and diagrams below. ☑

12.2 Install 17 ea Grounding Strips 6.00 x 2.75" (MA-368101) onto the Chamber as per Final Assy dwg (ME368220) and diagrams below. ☑





Panel Grounding Strips w/solder strip (side view)

Chamber Grounding Strip on top of Panel Grounding Strips (side view) 1.90"/2.75" (typical)

[signature]
Technician(s)

12.15.01
Date

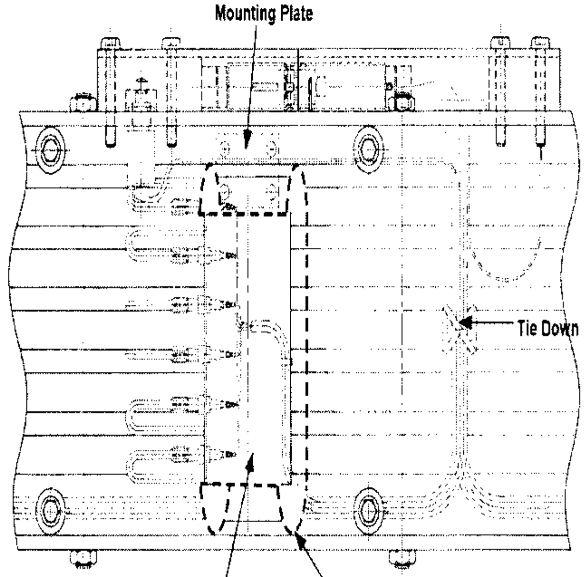
13.0 High Voltage Cable Assembly

Completed

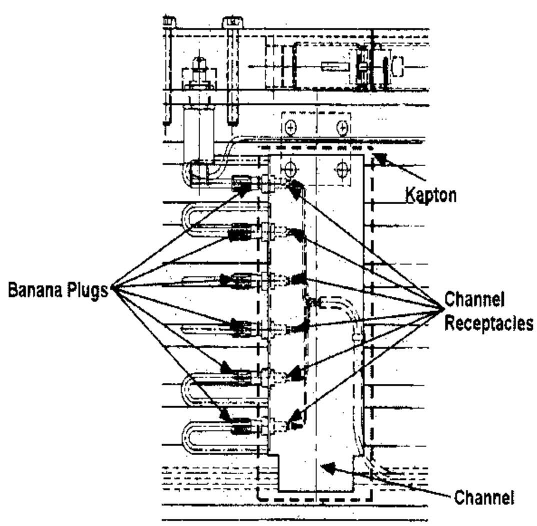
13.1 Tape kapton to the mounting plate (MA-368012 [5 ea.]). ☑

13.2 Secure the mounting plate (MA-368012) to the top HV side extrusion using the pan head screws (MA-368015), with the kapton placed as shown. ☑

13.3 Attach the HV channel to the mounting plate using polycarbonate RHS screws (MB-368328) as shown. ☑



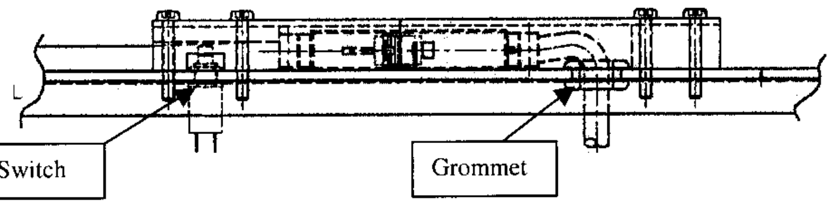
13.4 Plug in the HV banana plugs to the HV channel receptacles. ☑



Chamber Side View

Completed

13.5 Route the wires so they are in the bottom HV side extrusion, and the connector is on top of the top HV side excrusion. Place the grommet around the wires so the HV extrusion will not cut through the wires.



Chamber Side View

13.6 Place the first nut all the way down on the switch, and then install the switch to the top HV side excrusion, then tighten the second nut on the switch.

13.7 Strip the loose wires back about a ¼" down, and twist the wires together except wires 31 and 36. Solder the five wires to the grounding strip on the upper cathode panel.

13.8 Two pieces of shrink tubing should be placed over wires 31 and 36, and then solder the ends of these wires to prongs on the switch, and heat the shrink tubing around the prongs and wires.

Note(s):

If wires 31 and 36 are too short, splice a small piece of wire to 31 and 36, then Solder them together. Place shrink tubing over the splice and heat the shrink tubing

13.9 Run one or two cable ties through the two holes on the middle anode panel, and tie down the group of wires to the panel with the cable ties.

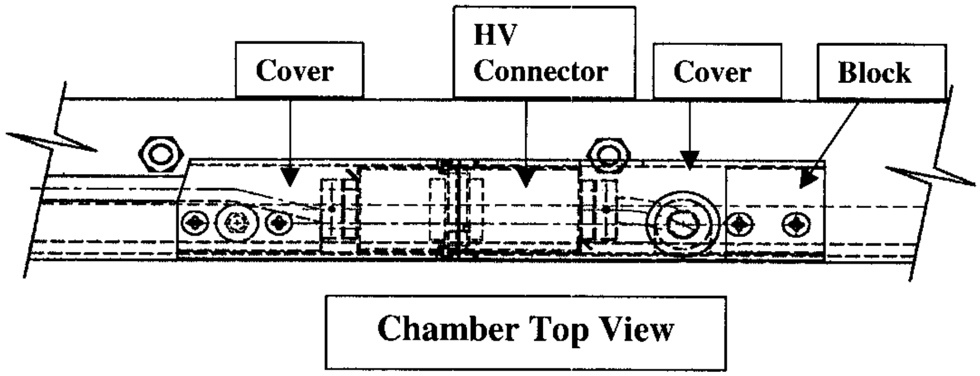
13.10 Tap (M6-1) the four holes in the top HV side excrusion for the HV cable assembly.

Note(s):

The hole tapping may only be required on the early production excursions where tapping operation was not included.

Completed

13.11 Position the connector and block on the top HV side excrusion, and then place the right cover over the connector and block and secure with the screws that are provided. ☑



13.12 Plug the adapter into the HV connector, push the switch and if the red light comes on the HV harness passes. Pass ☑ Fail ☐

13.13 Place the left cover and the two remaining screws in a baggie and tape to the top of the chamber. where shown on the engineering drawings. ☑

Technician(s) ____________ Date 12-15-01

14.0 Production Complete

XXX 14.1 Process Engineering verify that the CMS Chamber Assembly (5520-TR-333370) is accurate and complete. This shall include a review of all steps to ensure that all operations have been completed and signed off. Ensure that all Discrepancy Reports, Nonconformance Reports, Repair/Rework Forms, Deviation Index and dispositions have been reviewed by the Responsible Authority for conformance before being approved.

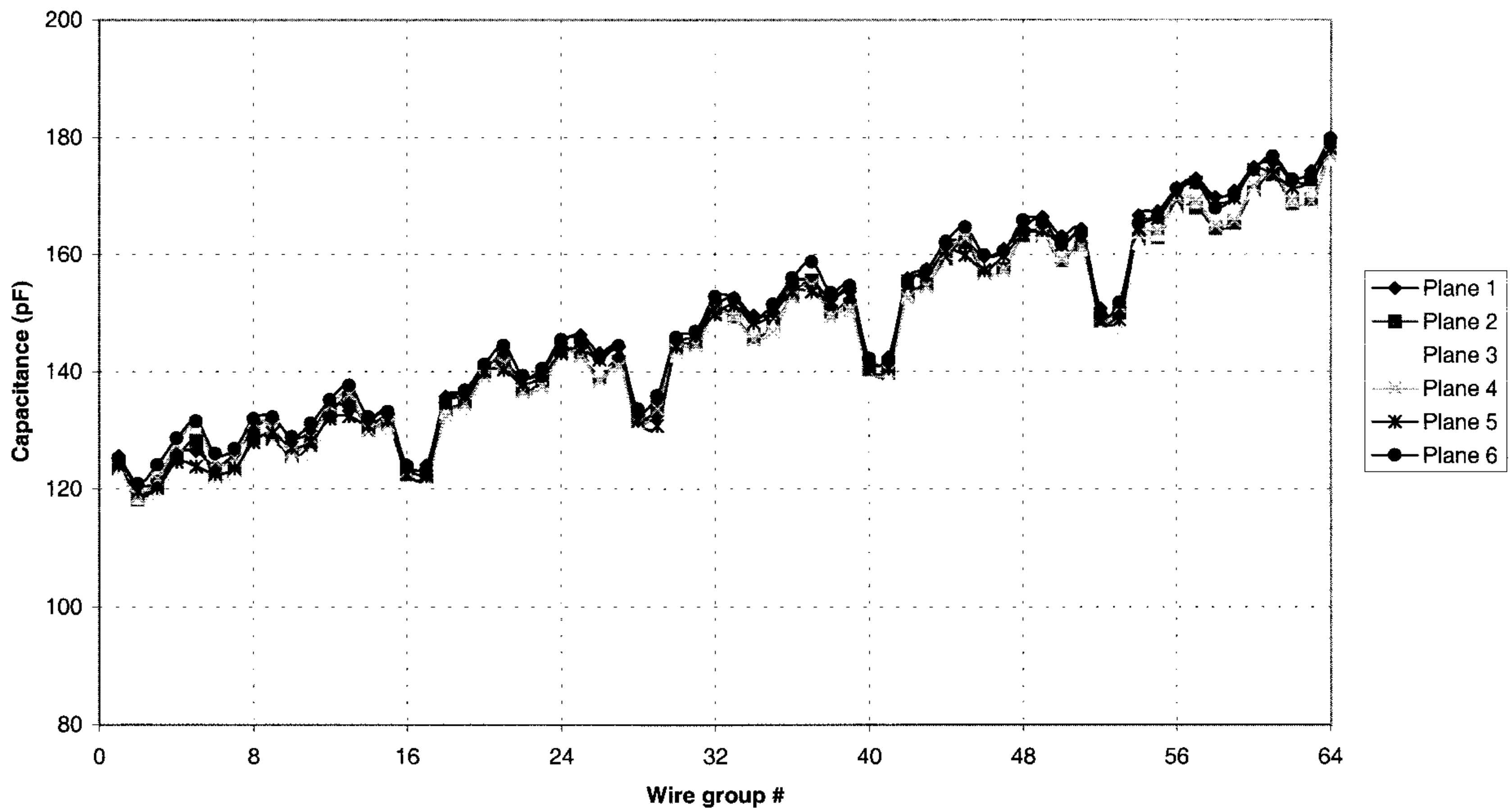
Comments:

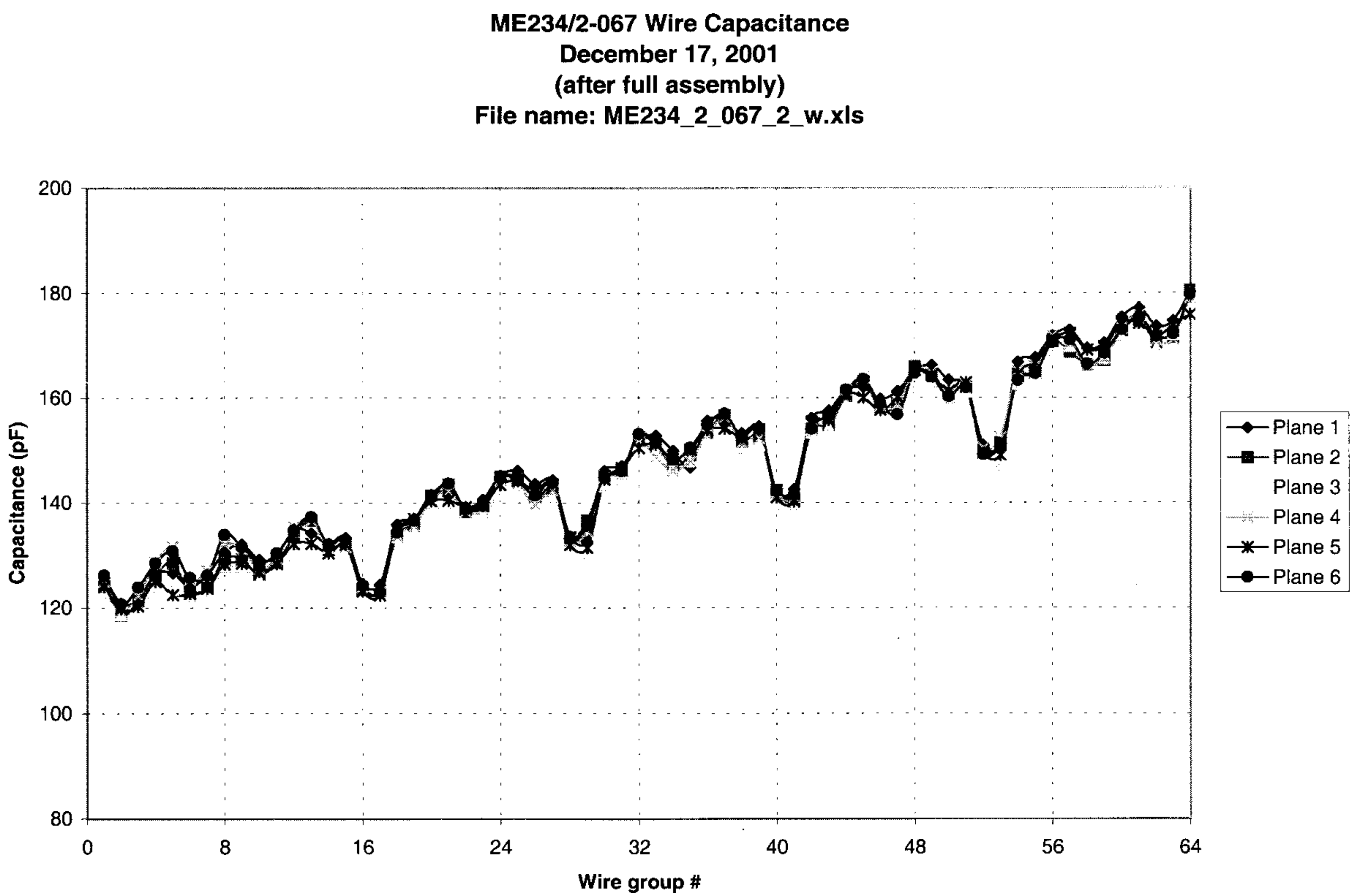
Pamela Elian
Process Engineering/Designee

1/11/02
Date

15.0 Proceed to the next major operation as required.

ME234/2-067 Wire Capacitance
December 12, 2001
(before full assembly)
File name: ME234_2_067_1_w.xls




ME234/2-067 Wire Capacitance
December 17, 2001
(after full assembly)
File name: ME234_2_067_2_w.xls
Capacitance (pF)
200
180
160
140
120
100
80
0
8
16
24
32
40
48
56
64
Wire group #
Plane 1
Plane 2
Plane 3
Plane 4
Plane 5
Plane 6

Chamber Anode Wire Group Capacitance Measurement

ME234/2-067

Wire Group		Protection Board #1							
		1	2	3	4	5	6	7	8
Non-Strip	**Plane 1**	125.83	120.86	121.64	126.42	126.63	124.01	126.29	130.53
Strip	**Plane 2**	124.24	118.58	121.33	126.26	128.52	122.92	123.86	129.33
Non-Strip	**Plane 3**	122.55	118.74	119.52	123.48	123.51	121.88	122.68	127.48
Strip	**Plane 4**	125.05	119.55	122.30	128.64	131.70	125.37	127.12	132.10
Non-Strip	**Plane 5**	124.03	119.88	120.33	124.95	122.52	122.70	123.67	128.29
Strip	**Plane 6**	126.20	120.69	123.91	128.48	130.75	125.70	126.15	133.89

Wire Group		Protection Board #2							
		9	10	11	12	13	14	15	16
Non-Strip	**Plane 1**	132.04	129.18	129.80	134.91	134.20	132.17	133.35	124.59
Strip	**Plane 2**	129.29	126.39	128.58	133.57	136.63	131.09	132.18	123.46
Non-Strip	**Plane 3**	127.79	125.26	124.58	130.66	131.41	128.58	129.08	120.57
Strip	**Plane 4**	131.08	127.37	129.39	135.32	136.63	131.42	131.53	123.95
Non-Strip	**Plane 5**	128.44	126.90	128.33	132.13	132.23	130.38	132.04	123.14
Strip	**Plane 6**	131.57	128.51	130.36	134.68	137.27	132.07	133.00	124.28

Wire Group		Protection Board #3							
		17	18	19	20	21	22	23	24
Non-Strip	**Plane 1**	124.35	135.87	136.97	141.44	141.94	139.20	140.57	145.16
Strip	**Plane 2**	123.10	133.88	136.00	141.35	143.48	138.28	139.36	144.97
Non-Strip	**Plane 3**	121.90	133.42	134.20	138.82	138.32	135.93	137.78	141.62
Strip	**Plane 4**	122.94	133.55	135.67	140.40	142.20	138.28	138.87	144.32
Non-Strip	**Plane 5**	122.39	134.72	136.97	140.29	140.46	139.20	139.42	143.39
Strip	**Plane 6**	122.94	134.36	136.64	141.04	143.64	138.77	139.52	144.81

Wire Group		Protection Board #4							
		25	26	27	28	29	30	31	32
Non-Strip	**Plane 1**	146.10	143.53	144.31	133.60	132.56	146.06	146.97	151.90
Strip	**Plane 2**	144.61	140.71	142.77	133.41	136.63	145.15	146.21	152.47
Non-Strip	**Plane 3**	142.83	140.60	140.89	129.68	129.60	143.12	144.35	151.26
Strip	**Plane 4**	143.63	139.57	142.28	132.77	134.57	144.49	145.56	151.66
Non-Strip	**Plane 5**	144.14	142.39	143.66	131.97	131.41	144.42	146.64	150.46
Strip	**Plane 6**	144.29	141.36	143.89	133.09	135.68	144.82	146.05	153.12

Technician: Irma Pl[illegible] **Date:** 12/17/01

Chamber Anode Wire Group Capacitance Measurement

ME234/2-067

Wire Group		Protection Board #5							
		33	34	35	36	37	38	39	40
Non-Strip	**Plane 1**	152.80	149.89	146.76	155.64	155.44	153.24	154.52	142.10
Strip	**Plane 2**	150.97	146.90	149.05	153.11	156.69	151.68	152.74	142.37
Non-Strip	**Plane 3**	150.03	146.63	147.90	152.37	151.49	149.65	151.07	138.89
Strip	**Plane 4**	148.69	146.25	147.92	152.95	156.21	151.36	152.25	141.88
Non-Strip	**Plane 5**	151.17	148.26	150.19	153.84	154.12	152.43	154.03	140.98
Strip	**Plane 6**	151.46	148.20	150.50	154.86	157.01	152.50	154.20	142.20

Wire Group		Protection Board #6							
		41	42	43	44	45	46	47	48
Non-Strip	**Plane 1**	142.50	156.09	157.53	161.35	162.02	159.78	161.25	165.08
Strip	**Plane 2**	140.54	154.06	154.69	160.42	163.21	157.89	158.77	166.00
Non-Strip	**Plane 3**	139.23	153.32	154.27	158.57	159.88	156.35	157.31	161.38
Strip	**Plane 4**	141.03	153.89	155.82	161.53	163.85	158.55	158.77	165.18
Non-Strip	**Plane 5**	140.21	155.44	155.73	160.70	160.05	157.65	160.10	165.24
Strip	**Plane 6**	141.52	154.06	156.79	161.53	163.53	158.88	156.81	164.69

Wire Group		Protection Board #7							
		49	50	51	52	53	54	55	56
Non-Strip	**Plane 1**	166.21	163.43	162.42	150.90	150.34	166.80	167.65	171.83
Strip	**Plane 2**	164.17	160.08	161.94	149.62	151.44	163.94	164.48	170.72
Non-Strip	**Plane 3**	162.62	160.17	161.12	147.15	147.04	162.56	164.37	167.65
Strip	**Plane 4**	164.82	160.57	162.43	150.41	152.39	165.09	165.95	171.86
Non-Strip	**Plane 5**	164.25	161.31	162.91	149.43	149.02	164.52	166.66	170.86
Strip	**Plane 6**	163.84	160.24	161.94	149.14	151.12	163.29	164.64	170.56

Wire Group		Protection Board #8							
		57	58	59	60	61	62	63	64
Non-Strip	**Plane 1**	172.92	169.46	170.42	175.39	177.17	173.66	174.71	180.18
Strip	**Plane 2**	168.73	166.26	167.10	172.81	174.83	170.48	171.50	180.50
Non-Strip	**Plane 3**	169.81	166.69	167.48	171.47	172.56	169.42	172.08	176.81
Strip	**Plane 4**	170.36	166.26	167.42	173.29	175.79	170.97	171.17	179.03
Non-Strip	**Plane 5**	172.26	169.14	169.76	174.08	174.20	171.70	173.88	175.84
Strip	**Plane 6**	171.01	166.43	168.55	172.97	175.31	171.79	172.15	179.69

Technician: Jnne Pde **Date:** 12/17/01

))) 67

TD/ENGINEERING & FABRICATION

PARTS KIT REQUEST

ORIGINAL

IMPORTANT NOTES:
1) MAGNET NUMBER MUST BE FILLED IN.
2) ONLY ONE FORM PER MAGNET.
3) PARTS COORDINATOR OR DESIGNEE MUST SIGN THIS FORM.
4) MATERIAL CONTROL WILL ISSUE PARTS AND RECORD ROUTING NUMBER.
5) ANY QUANTITIES NOT AVAILABLE WILL HAVE COMMENTS RETURNED TO THE PARTS COORDINATOR FOR REVIEW.

MAGNET NUMBER: ME234/2-[redacted] 67

RELEASED BY

PRODUCTION SIGNATURE: T J Gardner **BADGE#** 4569

TODAYS DATE: 22-Oct-01

NEED DATE:

DELIVER TO ____________ **MP 9**

BUDGET CODE: EPK

ISSUE VERIFICATION

MATERIAL CONTROL SIGNATURE: [signature]

DATE ISSUED TO STOCKROOM: 10-23-01

THIS KIT LIST IS FOR

ME-368220	D	ME 234/2 Muon Chamber Final Assembly

					MATERIAL			CONTROL		PROD	SUPT.
					QTY FILLED OUT BY STOCK ROOM			FILLED OUT BY EXPEDITER		VERIFY	VERIFY
PART NUMBER	REV	DESCRIPTION	REQUIRED QTY/ASS'Y		ISSUED	ROUTE FORM	NOT AVAIL	DATE AVAIL	COMMENTS TO PRODUCTION MANAGER	PART	PART
368005	A	Stud, Center Gap Bar, 5-40 UNC x 5.93"	4	EA	4	73611					✓
368006	C	Nut, Center Gap Bar Stud, 5-40 UNC	8	EA	8	74029					✓
368008	C	Upper Gas Flow Tube	1	EA	1	74963					✓
368009	B	Lower Gas Flow Tube	1	EA	1	74645					✓
368012	A	Mounting Plate	5	EA	5	~~[illegible]~~	73612				✓
368013	A	Label	2	EA	PROCESS ENG. TO PROVIDE						—
368015		Screw, Pan Head Phillips, stainless 6-32UNC x 3/8"	10	EA	10	70759					✓
368020	A	O-Ring, SiliC Rub., 9/16"ID x 3/4" OD	300	EA	300	72906					✓
368022	A	Bulkhead Connector, male M4 PT to 1/4" tube	2	EA	2	71955					✓
368027		Nylon Cable Tie	6	EA	6	71951					✓
368033	A	Test Strip Connector Label	1	EA	1	70061					✓
368054		Insulation Tubing,Mylar,Heat Shrink	20	EA	20	72052					✓
368097	A	Connector- Adapter	6	EA	6	74561					✓
368099	A	Test Strip Cable Assembly	6	EA	6	75512					✓
368101		Grounding Strip 6.00" x 2.75"	17	EA	17	70718					✓
368102	E	Cable Assembly, High Voltage	1	EA	1	76280					✓
368107		Grounding Strip 6.00x1.90	5	EA	5	69962					✓
368116		Street Elbow	2	EA	2	72322					✓
368117	A	Connector- Adapter	2	EA	2	72621					✓
368119		Cap Plug	2	EA	2	72022					✓
368221	D	Anode Panel Assembly	MP 9	HAS							—
368222	D	Upper Cathode Panel Assy	MP 9	HAS							—

RETURN THIS COMPLETED PARTS KIT REQUEST WITH THE ISSUED PARTS TO THE PARTS COORDINATOR.

J Van Kaer 11/01/2001 **: STOCKROOM SIGNATURE AND DATE**

TRAVELER NO. TR-XXXXXX

KIT IS COMPLETE (PARTS COORDINATOR SIGNATURE): [signature] **BADGE #** 3068C

DATE 11/15/01

67

TD/ENGINEERING & FABRICATION

PARTS KIT REQUEST

IMPORTANT NOTES:
1) MAGNET NUMBER MUST BE FILLED IN.
2) ONLY ONE FORM PER MAGNET.
3) PARTS COORDINATOR OR DESIGNEE MUST SIGN THIS FORM.
4) MATERIAL CONTROL WILL ISSUE PARTS AND RECORD ROUTING NUMBER.
5) ANY QUANTITIES NOT AVAILABLE WILL HAVE COMMENTS RETURNED TO THE PARTS COORDINATOR FOR REVIEW.

DELIVER TO ____________ MP 9

BUDGET CODE: EPK

RELEASED BY

MAGNET NUMBER: ME234/2- 67

PRODUCTION SIGNATURE: T J Gardner BADGE# 4569

TODAYS DATE: 22-Oct-01

NEED DATE: 0-Jan-00

ISSUE VERIFICATION

MATERIAL CONTROL SIGNATURE: [signature]

DATE ISSUED TO STOCKROOM: 10-25-01

THIS KIT LIST IS FOR

ME-368220	D	ME 234/2 Muon Chamber Final Assembly

PART NUMBER	REV	DESCRIPTION	REQUIRED QTY/ASS'Y		MATERIAL CONTROL: QTY FILLED OUT BY STOCK ROOM: ISSUED	ROUTE FORM	NOT AVAIL	FILLED OUT BY EXPEDITER: DATE AVAIL	COMMENTS TO PRODUCTION MANAGER	PROD VERIFY PART	SUPT. VERIFY PART
368223	E	Inner Cathode Panel Assy	MP 9	HAS							—
368224	B	Lower Cathode Panel Assy	MP 9	HAS							—
368291		Almit Solder	A/R								—
368328	A	Pan Head Screw	10	EA	10	70121					✓
368523	A	Cable Connector Mounting Block	1	EA	1	74334					✓
368524	B	Cable Connector Cover	1	EA	1	75961					✓
368525		Screw, Pan Head	4	EA	4	74310					✓
368526	A	Grommet	1	EA	1	74621					✓
368529	B	Channel Sub-Assembly	1	EA	1	75412					✓
368530		Pushbutton Switch	1	EA	1	72316					✓
368675		Insulating Strips	5	EA	5	75511					✓
368671		RTV 41	A/R								—
368674		RTV 9811	A/R								—

RETURN THIS COMPLETED PARTS KIT REQUEST WITH THE ISSUED PARTS TO THE PARTS COORDINATOR.

J VanKaes 11/01/2001 : STOCKROOM SIGNATURE AND DATE

TRAVELER NO. TR-XXXXXX

KIT IS COMPLETE (PARTS COORDINATOR SIGNATURE): [signature] BADGE # 30680

DATE 11/15/01

ORI...AL 67

TD/ENGINEERING & FABRICATION

PARTS KIT REQUEST

IMPORTANT NOTES:
1) MAGNET NUMBER MUST BE FILLED IN.
2) ONLY ONE FORM PER MAGNET.
3) PARTS COORDINATOR OR DESIGNEE MUST SIGN THIS FORM.
4) MATERIAL CONTROL WILL ISSUE PARTS AND RECORD ROUTING NUMBER.
5) ANY QUANTITIES NOT AVAILABLE WILL HAVE COMMENTS RETURNED TO THE PARTS COORDINATOR FOR REVIEW.

RELEASED BY

MAGNET NUMBER: 67 ME234/2-[redacted]

PRODUCTION SIGNATURE: T J Gardner **BADGE#** 4569

TODAYS DATE: 22-Oct-01

NEED DATE:

DELIVER TO ____________ **MP 9**

BUDGET CODE: EPK

ISSUE VERIFICATION

MATERIAL CONTROL SIGNATURE: [signature]

DATE ISSUED TO STOCKROOM: 10-23-01

THIS KIT LIST IS FOR

ME-368229	E	ME 234/2 Muon Chamber Frame Assembly

			MATERIAL				CONTROL			PROD	SUPT.
			REQUIRED		QTY FILLED OUT BY STOCK ROOM			FILLED OUT BY EXPEDITER		VERIFY	VERIFY
PART NUMBER	REV	DESCRIPTION	QTY/ASS'Y		ISSUED	ROUTE FORM	NOT AVAIL	DATE AVAIL	COMMENTS TO PRODUCTION MANAGER	PART	PART
368010	B	Washer, flat M10 x 30mm OD	6	EA	6	73192					✓
368011	C	Alignment pin	2	EA	2	74134					✓
368039		Nut, Hex M10-1.5 DIN 4398	94	EA	94	73314					✓
368043	B	Mounting Bracket YZ Fixed Top	1	EA	1	74460					✓
368044	B	Mounting Bracket Z Fixed Top	1	EA	1	74329					✓
368045	B	Mounting Bracket XYZ Fixed Top	1	EA	1	74286					✓
368046	A	Washer, Lock, Toothed	24	EA	24	73190					✓
368051	C	Panel Bolt "C"	6	EA	6	74451					✓
368052	C	Panel Bolt "B"	6	EA	6	73853					✓
368053	C	Panel Bolt "A"	32	EA	32	74450					✓
368055	A	Nut, Jam, SS 3/8-24-UNF	2	EA	2	73193					✓
368056	A	Washer, Flat, 3/8" AN960C SS	18	EA	18	73191					✓
368058	B	Bracket, Mounting YZ Fixed 5185C197	1	EA	1	74287					✓
368059	B	Bracket, Mounting Z Fixed 5185C198	1	EA	1	74331					✓
368060	C	Bracket, Mounting XYZ Fixed 5185C199	1	EA	1	74289					✓
368061	E	Extrusion, Top Small End 5185D255	1	EA	1	74503					✓
368062	E	Extrusion, Bottom Small End 5185D108	1	EA	1	74504					✓
368064	E	Side, Notched Bottom 5185E110	1	EA	1	74639					✓
368066	E	Side, Non-Notched Bpttom 5185E112	1	EA	1	74640					✓
368067	E	Extrusion, Top Big End 5185D226	1	EA	1	74596					✓
368068	F	Extrusion, Bottom Big End 5185D114	1	EA	1	74432					✓
368069	A	Screw, Thrd Forming M6-1 x 10	96	EA	96	72933					✓
368070	A	Washer, Lock, Toothed, Ext or Int	96	EA	96	73189					✓

RETURN THIS COMPLETED PARTS KIT REQUEST WITH THE ISSUED PARTS TO THE PARTS COORDINATOR.

[signature] 11/02/2001 **: STOCKROOM SIGNATURE AND DATE**

TRAVELER NO. TR-XXXXXX

KIT IS COMPLETE (PARTS COORDINATOR SIGNATURE): [signature] BADGE # 3066C

DATE 11/15/01

67

ORI[illegible]AL

TD/ENGINEERING & FABRICATION

PARTS KIT REQUEST

IMPORTANT NOTES:
1) MAGNET NUMBER MUST BE FILLED IN.
2) ONLY ONE FORM PER MAGNET.
3) PARTS COORDINATOR OR DESIGNEE MUST SIGN THIS FORM.
4) MATERIAL CONTROL WILL ISSUE PARTS AND RECORD ROUTING NUMBER.
5) ANY QUANTITIES NOT AVAILABLE WILL HAVE COMMENTS RETURNED TO THE PARTS COORDINATOR FOR REVIEW.

DELIVER TO ____________ MP 9

BUDGET CODE: EPK

RELEASED BY

MAGNET NUMBER: ME234/2[redacted] 67

PRODUCTION SIGNATURE: T J Gardner BADGE# 4569

TODAYS DATE: 22-Oct-01

NEED DATE: 0-Jan-00

ISSUE VERIFICATION

MATERIAL CONTROL SIGNATURE: [illegible signature]

DATE ISSUED TO STOCKROOM: 10-23-01

THIS KIT LIST IS FOR

ME-368229	E	ME 234/2 Muon Chamber Frame Assembly

PART NUMBER	REV	DESCRIPTION	REQUIRED QTY/ASS'Y		MATERIAL — QTY FILLED OUT BY STOCK ROOM: ISSUED	ROUTE FORM	NOT AVAIL	CONTROL — FILLED OUT BY EXPEDITER: DATE AVAIL	COMMENTS TO PRODUCTION MANAGER	PROD VERIFY PART	SUPT. VERIFY PART
368071	B	End Panel, Small 5185B115	2	EA	2	73490					✓
368072	B	Side Panel, 5185B116	1	EA	1	74082					✓
368073	B	End Panel, Big 5185B118	1	EA	1	72337					✓
368074	C	End Plate, Big 5185B211	2	EA	2	74421					✓
368075	B ~~C~~	End Plate, Small 5185B212	2	EA	2	74446					✓
368076	A	Screw, Thd Forming M6-1 x 16	30	EA	30	72934					✓
368077	A	Screw, F. Hd Cap M6-1 x 12 mm	6	EA	6	73188					✓
368079	C	Plate, Stiffening, P2 5185C164	4	EA	4	73471					✓
368080		Shim, Light, 2 Slot 5185B228	2	EA	2	72364					✓
368081		Shim, Medium, 2 Slot 5185B228	2	EA	2	72365					✓
368082		Shim, Heavy, 2 Slot 5185b228	4	EA	4	72367					✓
368083		Shim, Light, 3 Slot 5185C229	1	EA	1	72368					✓
368084		Shim, Medium, 3 Slot 5185C229	1	EA	1	72369					✓
368085		Shim, Heavy, 3 Slot 5185C229	2	EA	2	73936					✓
368105	C	Panel Side, Anode El.	1	EA	1	72343					✓
368167	B	Extrusion, Top Anode Side	1	EA	1	74813					✓
368168	C	Extrusion, Top HV Side	1	EA	1	74814					✓
368303	A	Corner Shim, Light	2	EA	2	72157					✓
368306	A	Corner Shim, Medium	2	EA	2	72373					✓
368309	A	Corner Shim, Heavy	6	EA	6	72374					✓
368684		Ring, Retaining, External Diameter .38	2	EA	2	76153					✓
368685		E-Ring	6	EA	6	76154					✓

RETURN THIS COMPLETED PARTS KIT REQUEST WITH THE ISSUED PARTS TO THE PARTS COORDINATOR.

[illegible signature] 11/02/2001 : STOCKROOM SIGNATURE AND DATE

TRAVELER NO. TR-XXXXXX

KIT IS COMPLETE (PARTS COORDINATOR SIGNATURE): [illegible signature] BADGE # 30682

DATE 11/15/01

Fermi National Accelerator Laboratory
Batavia, IL 60510

CMS ME234/2 CHAMBER CAPACITANCE TESTING TRAVELER

Reference Drawing(s)

Endcap Muon Chamber ME234/2 Final Assembly
5520-ME-368220

Endcap Muon Chamber ME234/2 Frame Assembly
5520-ME-368229

Budget Code:	**Project Code:**
Released by: Pamela Isham	**Date:** JUL 0 2 2001
Prepared by: M. Hubbard, B. Jensen, P Isham	

Title	Signature	Date
TD / E&F Process Engineering	Bob Jensen / Bob Jensen/designee	6/27/01
TD / E&F CMS Assembly	Glenn Smith / Glenn Smith/designee	6-27-01
Purdue University Technological Physicist	June Pal / Adam Bujak/designee	6/28/01
TD / E&F CMS Technological Physicist	Oleg Prokofiev/designee	6/28/01
TD / E&F CMS Project Manager	Apollinari / Giorgio Apollinari/designee	6/29/01

Revision Page

Revision	Step No.	Revision Description	TRR No.	Date
None	N/A	Initial Release	N/A	07/19/00
A	3.5	Removed "Properly fill out a PANEL SC-TEST Report Sheet" line.	1066	09/28/00
B	3.8	Added step 3.8	1189	6/27/01

Ensure appropriate memos and specific instructions are placed with the traveler before issuing the sub traveler binder to production.

1.0 General Notes

1.1 White (Lint Free) Gloves (Fermi stock 2250-1800) or Nitrile Gloves (Fermi stock 2250-2040) or equivalent, shall be worn by all personnel, as required, when handling all product parts after the parts have been prepared/cleaned.

1.2 All steps that require a sign-off shall include the Technician/Inspectors first initial and full last name.

1.3 No erasures or white out will be permitted to any documentation. All incorrectly entered data shall be corrected by placing a single line through the error, initial and date the error before adding the correct data.

1.4 All Discrepancy Reports issued shall be recorded in the left margin next to the applicable step.

1.5 All personnel performing steps in this traveler must have documented training for this traveler and associated operating procedures.

1.6 Personnel shall perform all tasks in accordance with current applicable ES&H guidelines and those specified within the step.

1.7 Cover the panel/chamber with Mylar when not being serviced or assembled.

1.8 Never hand pass anything over a panel as dropped items may damage the panel.

2.0 Parts Kit List

2.1 No Parts Kit Req'd

3.0 Chamber Transport

Completed

3.1 Transport the ME234/2 Chamber (MD-368220) using the Chamber Panel Cart (MD-368840) to the Chamber Capacitance Testing Station. ☑

Note:
Position the Chamber in a horizontal position with gas tubes to facing upward.

3.2 Remove the Big End Panel (MC-368073) from the Chamber Wide End Frame Assembly (ME-368229). ☑

3.3 Calibrate the Inter-Strip Capacitance Meter in accordance with Section 3.3 of the Inter-Strip Capacitance Operating Procedure 5520-OP-333472. ☑

Note:
Inter-Strip Capacitance Calibration needs to be performed only once a day before taking data.

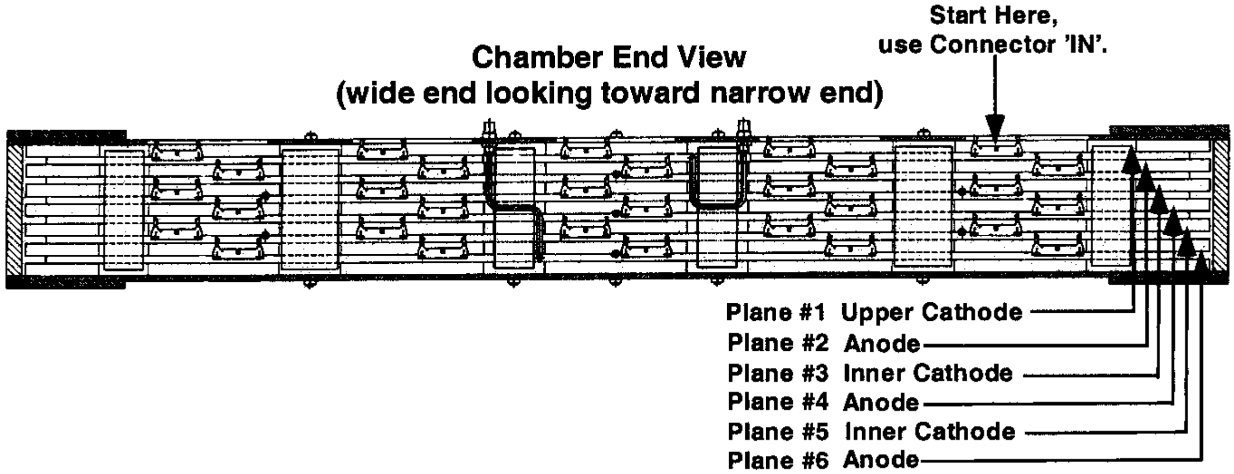
Calibrating Set	Pass ✓	Fail
Set – I	✓	
Set - II	✓	

Imre Bal

Technician(s)

8/16/01

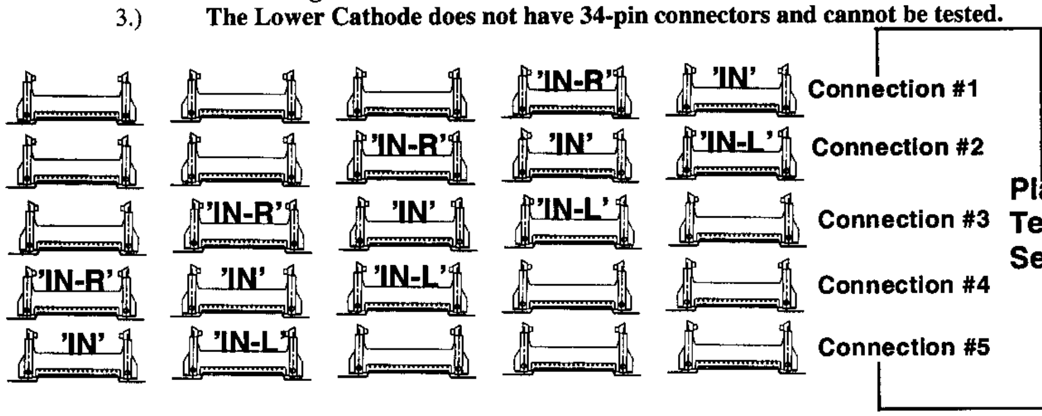
Date


Start Here,
use Connector 'IN'.
Chamber End View
(wide end looking toward narrow end)
Plane #1 Upper Cathode
Plane #2 Anode
Plane #3 Inner Cathode
Plane #4 Anode
Plane #5 Inner Cathode
Plane #6 Anode

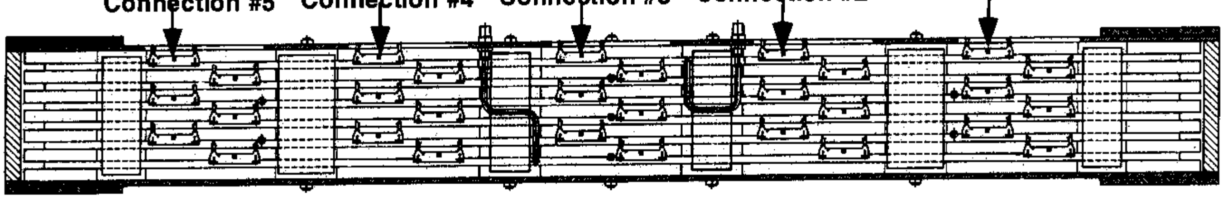
3.4 Measure the Inter-Strip Capacitances of each panel assembled into the Chamber beginning with the Upper Cathode. Repeat this for each of the six planes/panels to be measured.

Note:

1.) **Each Plane/Panel will have five (5) connections necessary to complete a plane/panel measurement.**
2.) **Ensure Ribbon Cable Connectors are installed in accordance with the below diagram.**
3.) **The Lower Cathode does not have 34-pin connectors and cannot be tested.**



Typical Ribbon Connector Hook-Up Sequence
(one plane/panel only)



Chamber End View
(wide end looking toward narrow end)

Plane	Panel	Completed
#1	Upper Cathode	✓
#2	Anode	✓
#3	Inner Cathode	✓
#4	Anode	✓
#5	Inner Cathode	✓
#6	Anode	✓

Imre Pal
Technician(s)

8/16/01
Date

Completed

3.5 The Chamber Capacitance Testing Technician must complete the following:

Record the Computer File Name ME234-2-045-3.xls ☑

Print a copy of the Chamber Capacitance Testing Report and attach it to this traveler. ☑

Record the number of Testing Report pages attached to this traveler. 3 ☑

June Pdl
Technician(s)

8/16/01
Date

3.6 Verify the Chamber is acceptable to proceed by reviewing the attached Chamber Capacitance Testing Report.

Chamber Acceptable to Proceed ☑ YES ☐ NO

If NO, explain: ______________________

Assembly/Designee

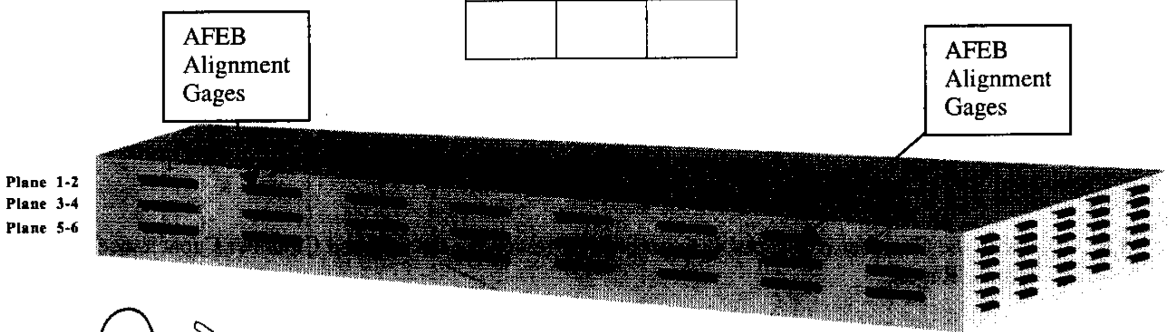
8/16/01
Date

3.7 Re-Install the Big End Panel (MC-368073) from the Chamber Wide End Frame Assembly (ME-368229). ☑

Completed

3.8 Place the Anode Side Panel Skin (368105) onto the Anode Side loosely. Connect the two AFEB Alignment Gages according by diagram below. Center the holes on the Anode side Panel with the holes on the AFEB Alignment Gages. If the holes do not line up, record the difference in the space provided below by fourths. Once the holes of the AFEB Alignment Gages and the Anode Side Panel lines up, tighten the bolts on the Anode Side Panel to the chamber.

1/4	1/2	3/4



Technician(s)

8-17-01
Date

4.0 Production Complete

XXX 4.1 Process Engineering verify that the CMS ME234/2 Chamber Capacitance Testing Traveler (5520-TR-333479) is accurate and complete. This shall include a review of all steps to ensure that all operations have been completed and signed off. Ensure that all Discrepancy Reports, Nonconformance Reports, Repair/Rework Forms, Deviation Index and dispositions have been reviewed by the Responsible Authority for conformance before being approved.

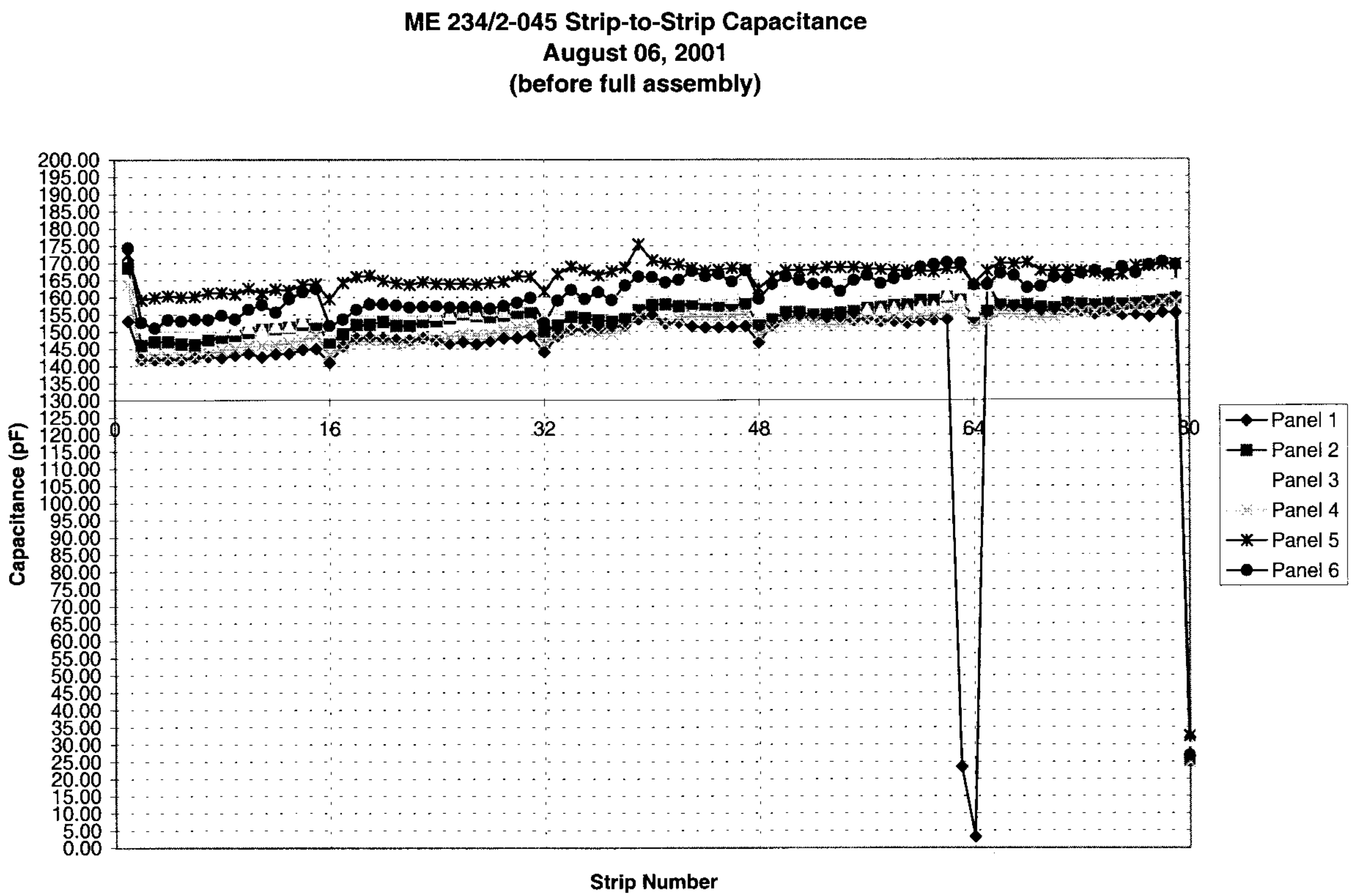
Comments:

Pamela Blau — 9/7/01
Process Engineering/Designee — Date

5.0 Attach the Process Engineering O.K. to Proceed Tag to the device that this production operation was performed on.

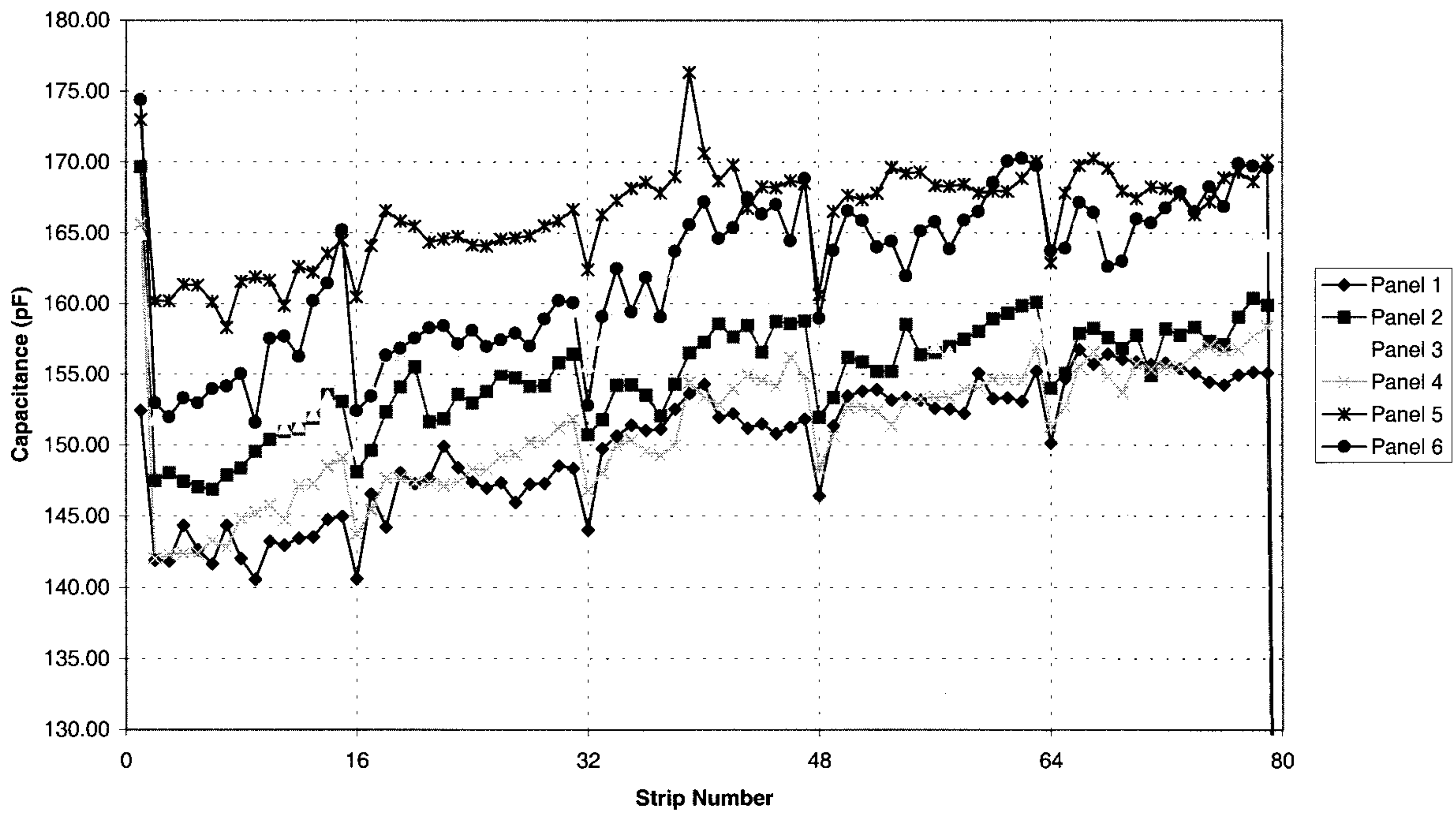
N/A
Process Engineering/Designee — Date

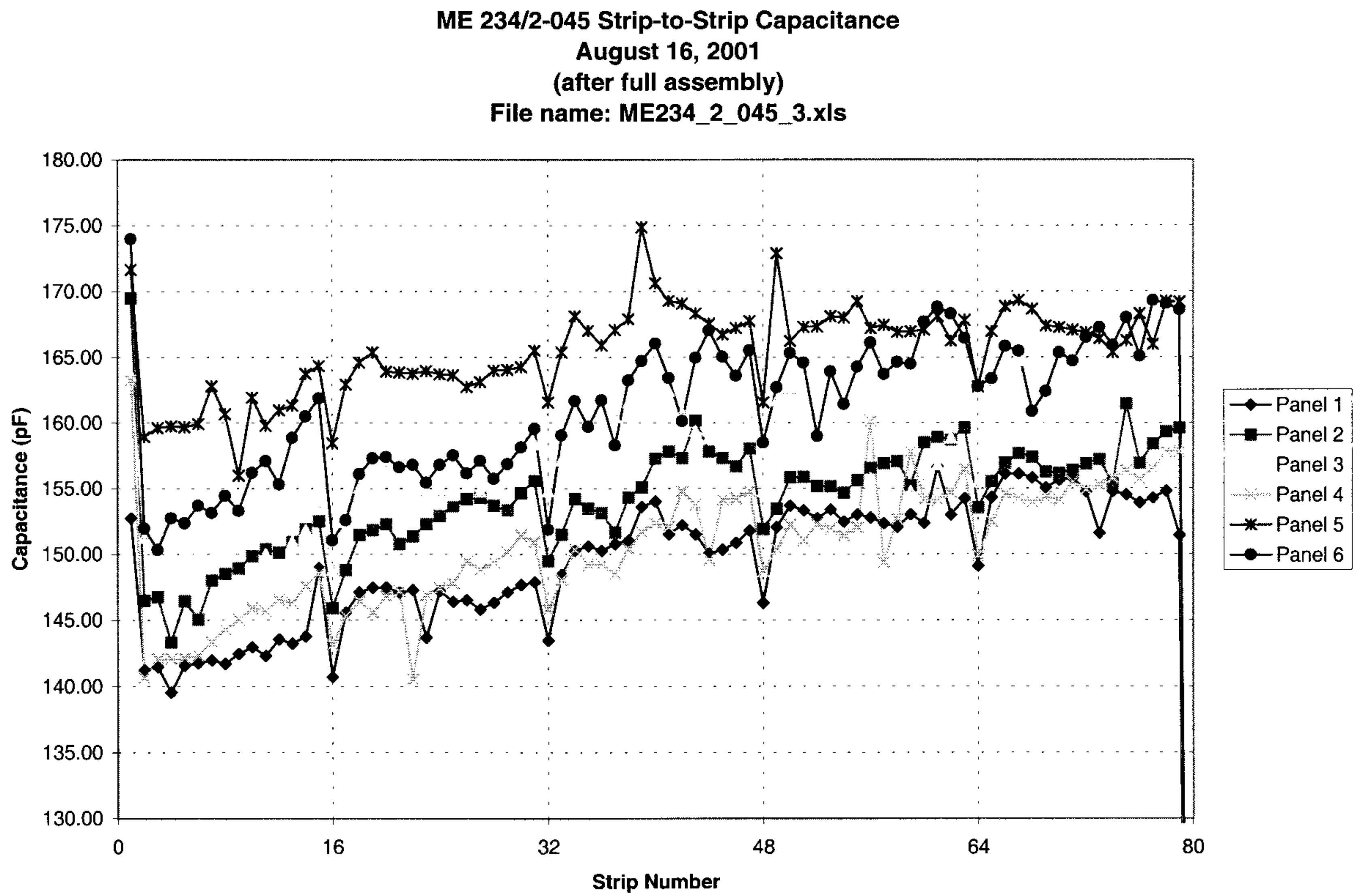
6.0 Proceed to the next major assembly operation.



ME 234/2-045 Strip-to-Strip Capacitance
August 06, 2001
(before full assembly)
Capacitance (pF)
200.00
195.00
190.00
185.00
180.00
175.00
170.00
165.00
160.00
155.00
150.00
145.00
140.00
135.00
130.00
125.00
120.00
115.00
110.00
105.00
100.00
95.00
90.00
85.00
80.00
75.00
70.00
65.00
60.00
55.00
50.00
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
0
16
32
48
64
80
Strip Number
Panel 1
Panel 2
Panel 3
Panel 4
Panel 5
Panel 6

ME 234/2-045 Strip-to-Strip Capacitance
August 08, 2001
(before full assembly)




ME 234/2-045 Strip-to-Strip Capacitance
August 16, 2001
(after full assembly)
File name: ME234_2_045_3.xls
Capacitance (pF)
180.00
175.00
170.00
165.00
160.00
155.00
150.00
145.00
140.00
135.00
130.00
0
16
32
48
64
80
Strip Number
Panel 1
Panel 2
Panel 3
Panel 4
Panel 5
Panel 6

Fermi National Accelerator Laboratory
Batavia, IL 60510

CMS ME234/2 CHAMBER CAPACITANCE TESTING TRAVELER

Reference Drawing(s)

Endcap Muon Chamber ME234/2 Final Assembly
5520-ME-368220

Endcap Muon Chamber ME234/2 Frame Assembly
5520-ME-368229

Magnet/Device Series: ME234/2	
Budget Code:	**Project Code:**
Released by: Pamela Isham	**Date:** NOV 1 4 2001
Date Closed: 1/11/02	**Scan Pages:** 11
Prepared by: B. Jensen, M. Hubbard, P. Isham	

Title	Signature	Date
TD / E&F Process Engineering	Bob Jensen / Bob Jensen/Designee	10/24/01
TD / E&F CMS Assembly	Glenn Smith / Glenn Smith/Designee	10/26/01
Purdue University Technological Physicist	Adam Bujak/designee	10/26/01
TD / E&F Technological Physicist	Oleg Prokofiev/Designee	10/26/01
TD / E&F CMS Project Manager	Giorgio Apollinari/Designee	10/26/01

Revision Page

Revision	Step No.	Revision Description	TRR No.	Date
None	N/A	Initial Release	N/A	07/19/00
A	3.5	Removed "Properly fill out a PANEL SC-TEST Report Sheet" line.	1066	09/28/00
B	3.8	Added step 3.8	1189	6/27/01
C	CVRPG	Added magnet device, date closed, scanned pages to the cover sheet, and serial number prefix to the bottom of the cover sheet.	1274	10/24/01
	5.0	Removed step 5.0 and signature line and date.		

Ensure appropriate memos and specific instructions are placed with the traveler before issuing the sub traveler binder to production.

1.0 General Notes

1.1 White (Lint Free) Gloves (Fermi stock 2250-1800) or Nitrile Gloves (Fermi stock 2250-2040) or equivalent, shall be worn by all personnel, as required, when handling all product parts after the parts have been prepared/cleaned.

1.2 All steps that require a sign-off shall include the Technician/Inspectors first initial and full last name.

1.3 No erasures or white out will be permitted to any documentation. All incorrectly entered data shall be corrected by placing a single line through the error, initial and date the error before adding the correct data.

1.4 All Discrepancy Reports issued shall be recorded in the left margin next to the applicable step.

1.5 All personnel performing steps in this traveler must have documented training for this traveler and associated operating procedures.

1.6 Personnel shall perform all tasks in accordance with current applicable ES&H guidelines and those specified within the step.

1.7 Cover the panel/chamber with Mylar when not being serviced or assembled.

1.8 Never hand pass anything over a panel as dropped items may damage the panel.

2.0 Parts Kit List

2.1 No Parts Kit Req'd

3.0 Chamber Transport

Completed

3.1 Transport the ME234/2 Chamber (MD-368220) using the Chamber Panel Cart (MD-368840) to the Chamber Capacitance Testing Station. ☑

Note:
Position the Chamber in a horizontal position with gas tubes to facing upward.

3.2 Remove the Big End Panel (MC-368073) from the Chamber Wide End Frame Assembly (ME-368229). ☑

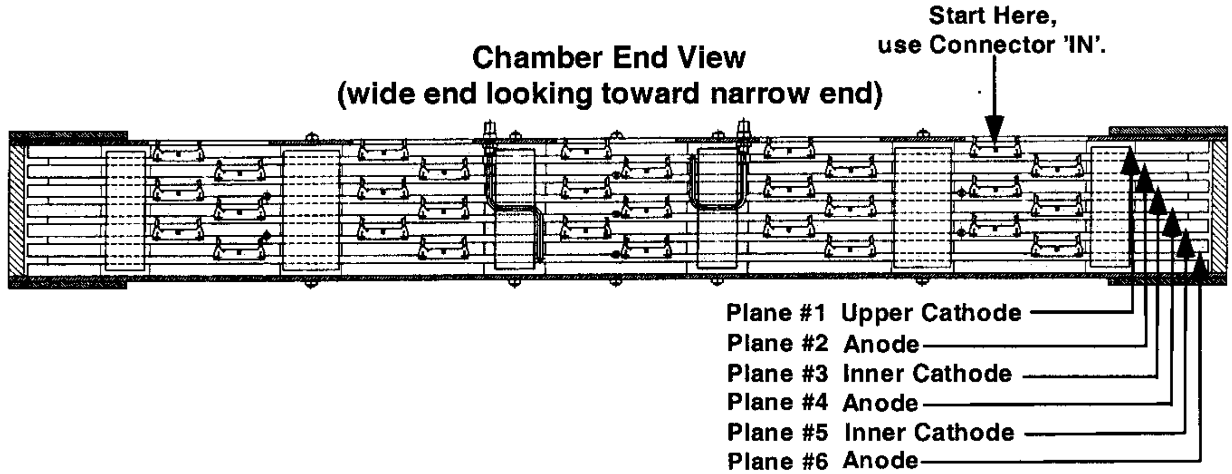
3.3 Calibrate the Inter-Strip Capacitance Meter in accordance with Section 3.3 of the Inter-Strip Capacitance Operating Procedure 5520-OP-333472. ☑

Note:
Inter-Strip Capacitance Calibration needs to be performed only once a day before taking data.

Calibrating Set	Pass	Fail
Set – I	✓	
Set - II	✓	

Jime PdC
Technician(s)

12/17/01
Date


Start Here,
use Connector 'IN'.
Chamber End View
(wide end looking toward narrow end)
Plane #1 Upper Cathode
Plane #2 Anode
Plane #3 Inner Cathode
Plane #4 Anode
Plane #5 Inner Cathode
Plane #6 Anode

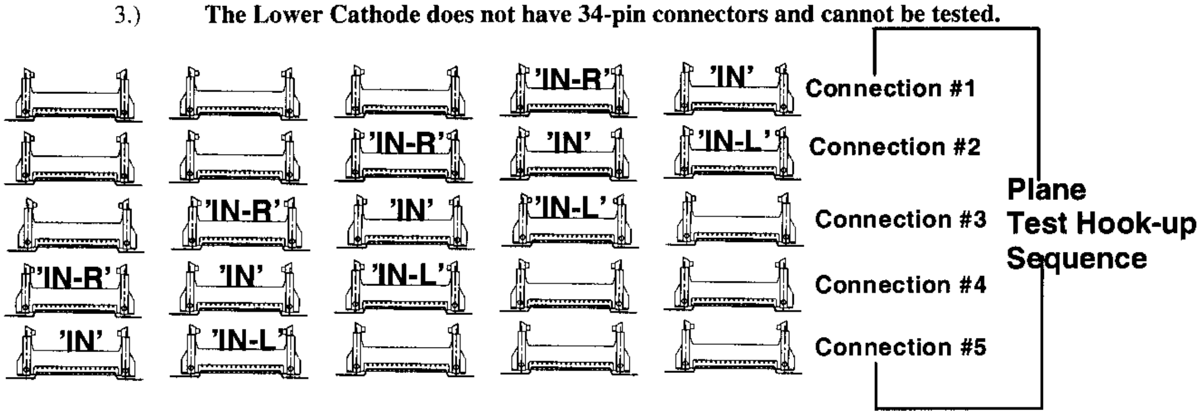
3.4 Measure the Inter-Strip Capacitances of each panel assembled into the Chamber beginning with the Upper Cathode. Repeat this for each of the six planes/panels to be measured.

Note:

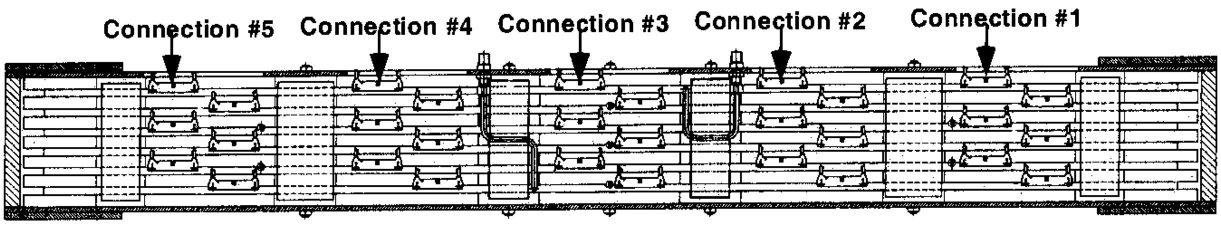
1.) **Each Plane/Panel will have five (5) connections necessary to complete a plane/panel measurement.**

2.) **Ensure Ribbon Cable Connectors are installed in accordance with the below diagram.**

3.) **The Lower Cathode does not have 34-pin connectors and cannot be tested.**



Typical Ribbon Connector Hook-Up Sequence.
(one plane/panel only)



Chamber End View
(wide end looking toward narrow end)

Plane	Panel	Completed
#1	Upper Cathode	✓
#2	Anode	✓
#3	Inner Cathode	✓
#4	Anode	✓
#5	Inner Cathode	✓
#6	Anode	✓

Jurre Pal
Technician(s)

12/17/01
Date

Completed

3.5 The Chamber Capacitance Testing Technician must complete the following:

Record the Computer File Name ME234-2_067_2.xls ☑

Print a copy of the Chamber Capacitance Testing Report and attach it to this traveler. ☑

Record the number of Testing Report pages attached to this traveler. 2 ☑

June Pell
Technician(s)

12/17/01
Date

3.6 Verify the Chamber is acceptable to proceed by reviewing the attached Chamber Capacitance Testing Report.

Chamber Acceptable to Proceed ☑ YES ☐ NO

If NO, explain: ______________________________

June Pell
Assembly/Designee

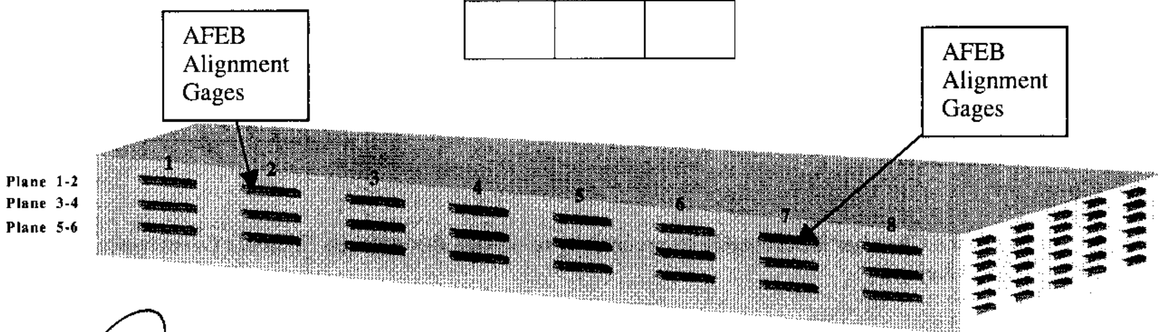
12/17/01
Date

3.7 Re-Install the Big End Panel (MC-368073) from the Chamber Wide End Frame Assembly (ME-368229). ☑

Completed

3.8 Place the Anode Side Panel Skin (368105) onto the Anode Side loosely. Connect the two AFEB Alignment Gages according by diagram below. Center the holes on the Anode side Panel with the holes on the AFEB Alignment Gages. If the holes do not line up, record the difference in the space provided below by fourths. Once the holes of the AFEB Alignment Gages and the Anode Side Panel lines up; tighten the bolts on the Anode Side Panel to the chamber.

1/4	1/2	3/4



Technician(s)

12-15-01
Date

4.0 Production Complete

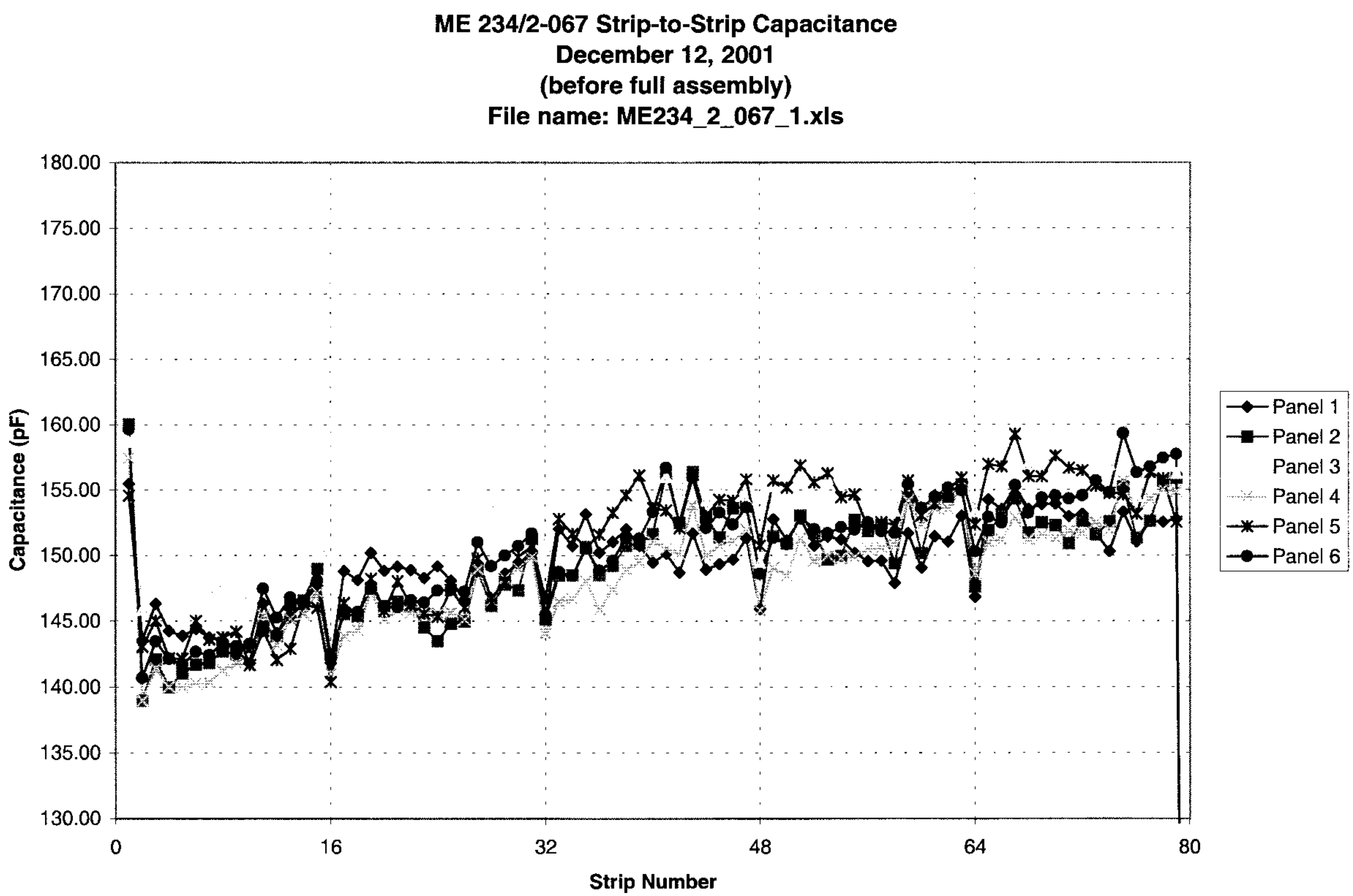
XXX 4.1 Process Engineering verify that the CMS ME234/2 Chamber Capacitance Testing Traveler (5520-TR-333479) is accurate and complete. This shall include a review of all steps to ensure that all operations have been completed and signed off. Ensure that all Discrepancy Reports, Nonconformance Reports, Repair/Rework Forms, Deviation Index and dispositions have been reviewed by the Responsible Authority for conformance before being approved.

Comments:

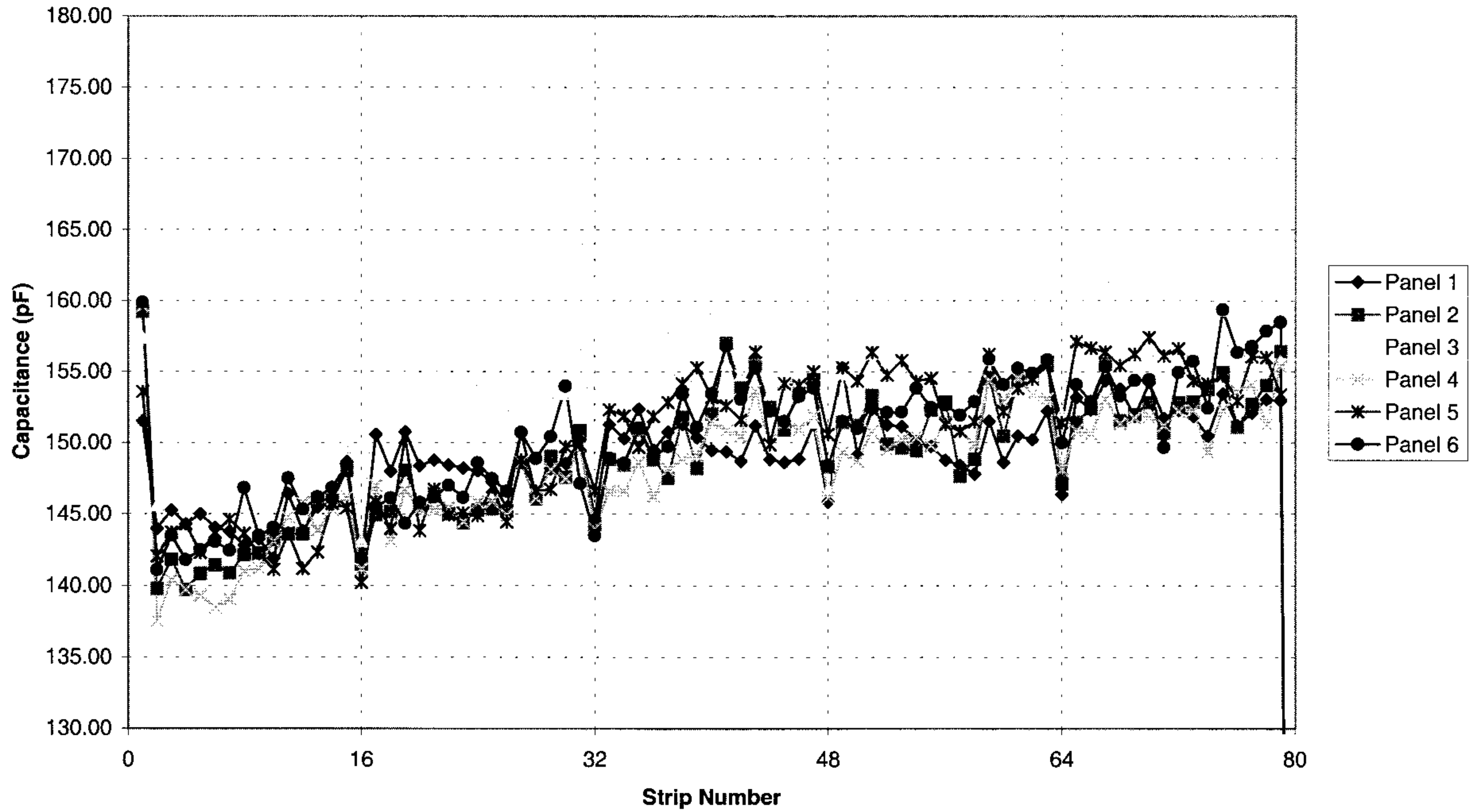
Pamela Blan
Process Engineering/Designee

Date 1/11/02

5.0 Proceed to the next major assembly operation.


ME 234/2-067 Strip-to-Strip Capacitance
December 12, 2001
(before full assembly)
File name: ME234_2_067_1.xls
Capacitance (pF)
180.00
175.00
170.00
165.00
160.00
155.00
150.00
145.00
140.00
135.00
130.00
0
16
32
48
64
80
Strip Number
Panel 1
Panel 2
Panel 3
Panel 4
Panel 5
Panel 6

ME 234/2-067 Strip-to-Strip Capacitance
December 17, 2001
(after full assembly)
File name: ME234_2_067_2.xls



Fermi National Accelerator Laboratory
Batavia, IL 60510

CMS ME234/2 CHAMBER ELECTRICAL TEST HIGH VOLTAGE TEST AND TRAINING TRAVELER

Reference Drawing(s)
Endcap Muon Chamber ME234/2 Final Assembly
5520-ME-368220

Endcap Muon Chamber Anode Panel Assembly
5520-ME-368254

Budget Code:	**Project Code:**	
Released by: Pamela [illegible]	**Date:** JUN 2 5 [illegible]	
Prepared by: M. Hubbard, B. Jensen, L. Lee, P. Isham		
Title	**Signature**	**Date**
TD / E&F Process Engineering	Bob Jensen **Bob Jensen/Designee**	4/27/01
TD / E&F CMS Assembly	[illegible] **Glenn Smith/Designee**	4/27/01
TD / E&F Technological Physicist	[illegible] **Oleg Prokofiev/Designee**	4/27/01
TD / CMS Project Manager	Apollinari **Giorgio Apollinari/Designee**	5/2/01

Revision Page

Revision	Step No.	Revision Description	TRR No.	Date
None	N/A	Initial Release	N/A	02/29/00
A	5.0	Changed time from "24 Hours" to "48 Hours" in the Note(s)	1068	10/09/00
	---	Removed the step "Terminate the Cathode Connectors to the ground."		
	---	"Cathode Strip Resistance" and "Anode Wire Group Capacitance" tests moved to the Assembly Traveler.		
	---	Removed the old "Inter-Strip Cathode Strip Capacitance Measurements."		
	5.3	Changed the layout of the Chart and added the line "Record current from each plane for 3.6kV and 4.0kV IF the Chamber Current is higher than 1uA."		
	---	Removed the separate measurement of current at 3.6kV and chart.		
	---	Removed the separate measurement of current at 4.0kV and chart.		
	6.0	Changed the layout of the Chart and corrected step 6.2 to reflect the proper procedure.		
	7.0	Added the "Re-Testing/Re-Training of Chamber"		
	---	Removed the separate measurement of current at 3.3kV and chart.		
	8.4	Added a new "Criterion" in Note(s), "No Corrona Signals"		
	8.5	Added a new chart and "Once the Chamber is acceptable, record the final current from each plane at 4.0kV in the chart below."		
	9.3	Added the "Chamber has passed..." step.		
B	4.4	Added a new note for gas test hook-up.	1113	02/06/01
C	5.0	Added HV harness test	1148	4/27/01

Ensure appropriate memos and specific instructions are placed with the traveler before issuing the sub traveler binder to production.

1.0 General Notes

1.1 White (Lint Free) Gloves (Fermi stock 2250-1800) or Nitrile Gloves (Fermi stock 2250-2040) shall be worn by all personnel when handling all product parts after the parts have been prepared/cleaned.

1.2 All steps that require a sign-off shall include the Technician/Inspectors first initial and full last name.

1.3 No erasures or white out will be permitted to any documentation. All incorrectly entered data shall be corrected by placing a single line through the error, initial and date the error before adding the correct data.

1.4 All Discrepancy Reports issued shall be recorded in the left margin next to the applicable step.

1.5 All personnel performing steps in this traveler must have documented training for this traveler and associated operating procedures.

1.6 Personnel shall perform all tasks in accordance with current applicable ES&H guidelines and those specified within the step.

1.7 Cover the panel/chamber with Mylar when not being serviced or assembled.

1.8 Never hand/ pass anything over a panel, damage could occur.

2.0 Parts Kit List

2.1 Attach the completed Parts Kit List for the CMS Chamber Test And Training to this traveler. Ensure that the serial number on the Parts Kit List matches the serial number of this traveler. Verify that the Parts Kit received is complete.

Pamela Ikha ________________ JUN 2 5 2001 ________________

Process Engineering/Designee Date

3.0 Chamber Electrical Test Preparation

Completed

3.1 Put chamber on Chamber transportation cart; fix Chamber in the vertical position and move to the Chamber Electrical Test Stand. ☑

3.2 Acquire the Chamber (ME-368220) as per the Chamber Serial Number at the bottom of this traveler ☑

3.3 Transfer and fix chamber to the Test Stand. Remove Chamber Transportation Cart. ☑

Dan Eddy
Technician(s)

8/14/01
Date

4.0 Chamber Gas Mixture Setting

4.1 Select gas mixture setup (line) on the gas distribution rack corresponding to the Test Stand with the Chamber mounted on it. ☑

4.2 Slowly open three 2-way gas selection valves to bring Argon, Carbon Dioxide and Freon 14 to the corresponding rotameters. (10%CF_4 40%AR, 50%CO_2) ☑

4.3 Check flow rate of rotameters and set if it is needed to desired flow rates. ☑
Flow Rate should be 0.4L/min.

Note(s):

Be sure that rotameter reading at ball center is in the range µ 1/8" of marked position.

4.4 Connect gas mixture manifold to the chamber inlet and connect chamber outlet to the Bubbler. Bubbles will pass through Bubblers. ☑

Note(s):

When a new chamber comes in to be tested with gas, hook-up the new chamber 'downstream' from the existing chamber, in the second position along the gas line.

4.5 Record the Gas Channel used, date and time the gas mixture purge started through the Chamber ☑

	Gas Channel	Date	Time
Gas Mixture Purge Start	1	8/14/01	14:30

Dan Eddy
Technician(s)

8/14/01
Date

5.0 High Voltage Harness Test

Completed ☑

5.1 Interlock line test. ☑
Pushbutton switch is normally open. Push down switch and check by multimeter Resistance between lines 31 and 36 on the patch panel.
Pass: less than 5 Ohm at push down switch position

Interlock schematic Layout tests	Pass	Fail
	✓	

5.2 HV harness schematic layout test ☑
Connect patch panel to HV power supply, set 30 V and put voltage to each HV segment one by one. Measure voltage on the chamber segment.

Schematic Layout test	Pass (30 V)	Fail (no voltage)
	✓	

5.3 HV test of harness ☑
Connect patch panel to HV power supply, set 4.0 kV and put voltage to all HV Segments on the chamber. Measure current on the HV power supply. Record data into table below.

Note(s):
HV chamber jumpers will be disconnected. It is extremely important.

High voltage, kV	Current, nA	Time, start	Time, stop	Humidity	Temperature
4.0 kV	70	13:40	——	47%	71.7°F
4.0 kV	2	——	13:50	47%	71.7°F

5.3.1 Criteria of good harness: current at 4.0 kV after 10 min. will be less 30 nA. ☑

Pass	Fail
✓	

Comments:
CHAMBER PURGE SHUT OFF AFTER TEST. NOT ENOUGH GAS TO CONTINUE. RESTARTED GAS PURGE 8·21·01 (7:45) GAS ARRIVED 8/20/01 (14:30). WILL START HV TESTING 8/23/01

Completed

5.4 Connect chamber HV jumper to harness (switchboard terminal on the red channel) and start chamber HV test and training. ☑

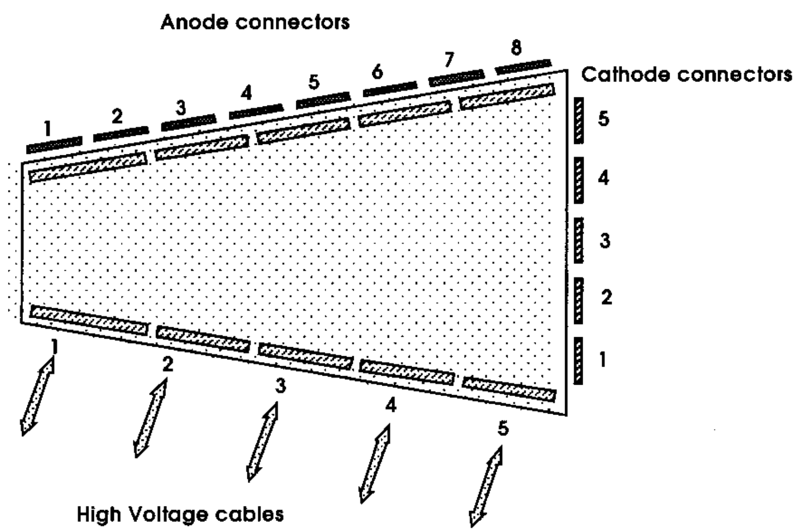
Technician(s) _______ Date 8·23·01

6.0 Chamber High voltage test.

Note(s):

Be sure that before starting High Voltage tests the chamber was purged with working gas mixture at least 48 hours.

6.1 Connect chamber to the High Voltage power supply (Model 6900). ☑



6.2 Raise slowly High Voltage up to 4.0 kV (up to 15 minutes per voltage step).
Record current data from the chamber to the table.
Record the current from each plane for 3.6 kV and 4.0 kV **if** the Chamber current is higher than 1 μA

	Chamber All Panels	Time		Plane #					
				1	2	3	4	5	6
HV KV	**I μA**	**Start/ Stop**	**Date**	**I μA**	**I μA**	**I μA**	**I μA**	**I μA**	**I μA**
1.0	.01	11:22	8/23						
2.0	.02	11:24	8/23						
3.0	0.2	11:25	8/23						
3.2	0.2	11:27	8/23						
3.4	0.2	11:29	8/23						
3.6	0.1	11:30	8/23						
3.7	0.2	11:31	8/23						
3.8	0.3	11:32	8/23						
3.9	0.4	11:33	8/23						
4.0	2.8	11:34	8/23	SEG1 -1.0	SEG1 - .4	SEG5 - .6		SEG5 - .6	

Remarks:

Note(s):

In case of corona or high current more than 5.0 μA per plane:
specify and disconnect High Voltage Segment
continue raise High Voltage in accordance with procedure

David Eddy
Technician(s)

8.23.01
Date

7.0 Chamber High Voltage Training With Reverse Polarity

Completed

7.1 Connect chamber to the High Voltage power supply with reverse polarity (Model 5900). ☑

7.2 Slowly raise the High Voltage up to 3.3 kV (Current must be less than 30-50 μA.). ☑
Keep the Chamber at 3.3 kV for 20-30 minutes or until the current drops to zero.
Record current data from the chamber to the table.
Record the current from each plane for 3.3 kV.

Note(s):

Don't keep Chamber under reverse High Voltage more than 1 hour.

Reverse Polarity Test #1

	Chamber All Panels	Time		Plane #					
				1	2	3	4	5	6
HV KV	I μA	Start/ Stop	Date	I μA	I μA	I μA	I μA	I μA	I μA
2.4	0.2	13:07	8/23						
2.5	0.2	13:08	8/23						
2.6	0.2	13:10	8/23						
2.7	0.2	13:12	8/23						
2.8	0.1	13:13	8/23						
2.9	0.1	13:14	8/23						
3.0	0.1	13:15	8/23						
3.1	0.1	13:16	8/23						
3.2	0.1	13:17	8/23						
3.3	.01	13:50	8/23						

Remarks:

Technician(s): Dan Eddy

Date: 8/23/01

8.0 Re-testing/Re-Training of Chamber

8.1 Re-test the Chamber by slowly raising the High Voltage up to 4.0 kV (up to 15 minutes per voltage step). Record current data from the chamber to the table.
Record the current from each plane for 3.6 kV and 4.0 kV **if** the Chamber current is higher than 1 μA

	Chamber All Panels	**Time**		**Plane #**					
				1	**2**	**3**	**4**	**5**	**6**
HV KV	**I μA**	**Start/ Stop**	**Date**	**I μA**	**I μA**	**I μA**	**I μA**	**I μA**	**I μA**
1.0	.0.1	14:05	8/23						
2.0	0.2	14:07	8/23						
3.0	0.2	14:09	8/23						
3.2	0.1	14:11	8/23						
3.4	0.1	14:13	8/23						
3.6	0.1	14:15	8/23						
3.7	0.1	14:17	8/23						
3.8	0.1	14:19	8/23						
3.9	0.3	14:21	8/23						
4.0	1.4	14:23	8/23						

Remarks: CURRENT FROM PLANE 2, 3, 5. REVERSE POLARITY WHOLE CHAMBER. 20 MIN AT 3.35 KV

Note(s):

In case of corona or high current more than 5.0 μA per plane:
specify and disconnect High Voltage Segment
continue raise High Voltage in accordance with procedure

Daniel Eddy
Technician(s)

8/23/01
Date

Completed

8.2 Perform 2nd Reverse Polarity test ONLY if discrepancies occurred in step 7.1. ☑

Note(s):

A discrepancy occurs when the current for some segment exceeds 1.0 μA

8.2.1 Connect chamber to the High Voltage power supply with reverse polarity. ☑

8.2.2 Slowly raise the High Voltage up to 3.3 kV (Current must be less than 30-50 μA.). ☑
Keep the Chamber at 3.3 kV for 20-30 minutes or until the current drops to zero.
Record current data from the chamber to the table.
Record the current from each plane for 3.3 kV.

Note(s):

Don't keep Chamber under reverse High Voltage more than 1 hour.

Reverse Polarity Test #2

	Chamber All Panels	Time		Plane #					
				1	2	3	4	5	6
HV kV	I μA	Start/ Stop	Date	I μA	I μA	I μA	I μA	I μA	I μA
~~2.4~~ 3.35	.3	14:41	8/23						
~~2.5~~ 3.35	.03	15:01	8/23						
2.6									
2.7									
2.8									
2.9									
3.0									
3.1									
3.2									
3.3									

Remarks:

D. Eddy
Technician(s)

8/23/01
Date

9.0 Chamber High voltage training with normal polarity.

Completed

9.1 Connect chamber to the High Voltage power supply with normal polarity. ☑

9.2 Slowly raise the High Voltage up to 3.8-4.0 kV until the Chamber current reaches between 1.0-2.0μA. ☑

9.3 Start the training procedure. Keep the chamber under high voltage for 1-2 days until the current drops to 0.1 μA or less per plane. Increase High Voltage for 0.1kV and continue chamber training.
Record current data from the chamber to the table. ☑

	Chamber All Panels	Time		Plane #					
				1	2	3	4	5	6
HV KV	I μA	Start/ Stop	Date	I μA	I μA	I μA	I μA	I μA	I μA
4.0	2.0	15:05	8/23						
3.9	.28	15:05	8/23	KEEP AT 3.9KV FOR NOW.					
3.9	.1	7.50	8/24						
4.0	.2	7:51	8/24						
4.0	.1	13:30	8/24						
4.0	.1	15:35	8/24						
4.0	.1	6:55	8/25						
4.0	.1	12:00	8/25	CHAMBER PASSES HV TESTING					

Remarks:

Technician(s): [signature]

Date: 8.24.01

9.4 Keep chamber at 4.0 kV at least 24 hours.
Record data into table.

	Chamber All Panels	Time		Plane #					
				1	2	3	4	5	6
HV KV	I μA	Start/ Stop	Date	I μA	I μA	I μA	I μA	I μA	I μA
4.0									
4.0									
4.0									
4.0									
4.0									
4.0									
4.0									
4.0									
4.0									
4.0									

Note(s):

Criterion of the good chamber:

-Current less than 0.1μA per plane for 24 hours.

-No current trip at 10μA trip set for 24 hours.

-No Corona Signals.

9.5 Once the Chamber is acceptable, record the final current from each plane at 4.0 kV in the chart below.

KV	Chamber Current	Plane #						Time	Date
		1	2	3	4	5	6		
4.0	.12	.02	.02	.03	.02	.03	.02	12:10	8/25/01

David Eddy
Technician(s)

8/25/01
Date

10.0 Chamber Cosmic Test

Completed

10.1 Connect the Scope to the protection board. ☑

10.2 Check anode signals from all anode protection boards. ☑

Note(s):

After measurements are completed inform supervisor if any signals are missing or any Corona signals are present from anode protection boards.

Daniel Eddy
Technician(s)

8/25/01
Date

10.3 The Chamber has passed the High Voltage Test and Training and meets the criterion for a good Chamber based on the Note(s) below step 8.4.

Daniel Eddy
Technician(s)

8/25/01
Date

11.0 Production Complete

XXX 11.1 Process Engineering verify that the Electrical Test / HV Test and Training (5520-TR-3332) is accurate and complete. This shall include a review of all steps to ensure that all operations have been completed and signed off. Ensure that all Discrepancy Reports, Nonconformance Reports, Repair/Rework Forms, Deviation Index and dispositions have been reviewed by the Responsible Authority for conformance before being approved.

Comments:

Pamela Bhan
Process Engineering/Designee

9/7/01
Date

12.0 Attach the Process Engineering "OK to Proceed" Tag on the panel.

N/A
Process Engineering/Designee

Date

13.0 Proceed to the next major assembly operation as required.

Fermi National Accelerator Laboratory
Batavia, IL 60510

CMS ME234/2 CHAMBER ELECTRICAL TEST HIGH VOLTAGE TEST AND TRAINING TRAVELER

Reference Drawing(s)

Endcap Muon Chamber ME234/2 Final Assembly
5520-ME-368220

Endcap Muon Chamber ME234/2 Frame Assembly
5520-ME-368229

Magnet/Device Series: ME234/2	
Budget Code:	**Project Code:**
Released by: Pamela Isham	**Date:** NOV 14 2001
Date Closed: 1/11/02	**Scan Pages:** 19
Prepared by: B. Jensen, M. Hubbard, L. Lee, P. Isham	

Title	Signature	Date
TD / E&F Process Engineering	Bob Jensen Bob Jensen/Designee	11/8/01
TD / E&F CMS Assembly	Glenn Smith Glenn Smith/Designee	11/08/01
TD / E&F Technological Physicist	Oleg Prokofiev/Designee	11/08/01
TD / E&F CMS Project Manager	Apollinari Giorgio Giorgio Apollinari/Designee	11/08/01

Revision Page

Revision	Step No.	Revision Description	TRR No.	Date
None	N/A	Initial Release	N/A	02/29/00
A	5.0	Changed time from "24 Hours" to "48 Hours" in the Note(s)	1068	10/09/00
	---	Removed the step "Terminate the Cathode Connectors to the ground."		
	---	"Cathode Strip Resistance" and "Anode Wire Group Capacitance" tests moved to the Assembly Traveler.		
	---	Removed the old "Inter-Strip Cathode Strip Capacitance Measurements."		
	5.3	Changed the layout of the Chart and added the line "Record current from each plane for 3.6kV and 4.0kV IF the Chamber Current is higher than 1uA."		
	---	Removed the separate measurement of current at 3.6kV and chart.		
	---	Removed the separate measurement of current at 4.0kV and chart.		
	6.0	Changed the layout of the Chart and corrected step 6.2 to reflect the proper procedure.		
	7.0	Added the "Re-Testing/Re-Training of Chamber"		
	---	Removed the separate measurement of current at 3.3kV and chart.		
	8.4	Added a new "Criterion" in Note(s), "No Corrona Signals"		
	8.5	Added a new chart and "Once the Chamber is acceptable, record the final current from each plane at 4.0kV in the chart below."		
	9.3	Added the "Chamber has passed…" step.		
B	4.4	Added a new note for gas test hook-up.	1113	02/06/01
C	5.0	Added HV harness test	1148	4/27/01
D	9.0	Added step 9.0, Chamber final.	1241	10/3/01
	12.0	Removed step 12.0, and signature line.		
E	CVRPG	Added magnet device, date closed, scanned pages to the cover sheet, and serial number prefix to the bottom of the cover sheet.	1276	10/24/01
	2.1	Change step 2.1 to refer to specification # 333370.		
	11.4	Added step 11.4 apply the silver sticker.		
F	CVRPG	Added the serial number prefix.	1285	11/7/01
	9.0	Moved 9.0 to 11.0.		
	11.21	Added step 11.21 Apply Avery labels.		
	11.22	Removed Tech. signature line and date.		

Ensure appropriate memos and specific instructions are placed with the traveler before issuing the sub traveler binder to production.

1.0 General Notes

1.1 White (Lint Free) Gloves (Fermi stock 2250-1800) or Nitrile Gloves (Fermi stock 2250-2040) shall be worn by all personnel when handling all product parts after the parts have been prepared/cleaned.

1.2 All steps that require a sign-off shall include the Technician/Inspectors first initial and full last name.

1.3 No erasures or white out will be permitted to any documentation. All incorrectly entered data shall be corrected by placing a single line through the error, initial and date the error before adding the correct data.

1.4 All Discrepancy Reports issued shall be recorded in the left margin next to the applicable step.

1.5 All personnel performing steps in this traveler must have documented training for this traveler and associated operating procedures.

1.6 Personnel shall perform all tasks in accordance with current applicable ES&H guidelines and those specified within the step.

1.7 Cover the panel/chamber with Mylar when not being serviced or assembled.

1.8 Never hand/ pass anything over a panel, damage could occur.

2.0 Parts Kit List

2.1 Refer to specification # 5520-TR-333370.

3.0 Chamber Electrical Test Preparation

Completed

3.1 Put chamber on Chamber transportation cart; fix Chamber in the vertical position and move to the Chamber Electrical Test Stand. ☑

3.2 Acquire the Chamber (ME-368220) as per the Chamber Serial Number at the bottom of this traveler ☑

3.3 Transfer and fix chamber to the Test Stand. Remove Chamber Transportation Cart. ☑

D. Eddy
Technician(s)

12-17-01
Date

4.0 Chamber Gas Mixture Setting

4.1 Select gas mixture setup (line) on the gas distribution rack corresponding to the Test Stand with the Chamber mounted on it. ☑

4.2 Slowly open three 2-way gas selection valves to bring Argon, Carbon Dioxide and Freon 14 to the corresponding rotameters. (10%CF_4 40%AR, 50%CO_2) ☑

4.3 Check flow rate of rotameters and set if it is needed to desired flow rates. ☑
Flow Rate should be 0.4L/min.

Note(s):
Be sure that rotameter reading at ball center is in the range ∓ 1/8" of marked position.

4.4 Connect gas mixture manifold to the chamber inlet and connect chamber outlet to the Bubbler. Bubbles will pass through Bubblers. ☑

Note(s):
When a new chamber comes in to be tested with gas, hook-up the new chamber 'downstream' from the existing chamber, in the second position along the gas line.

4.5 Record the Gas Channel used, date and time the gas mixture purge started through the Chamber ☑

	Gas Channel	Date	Time
Gas Mixture Purge Start	1	12-17-01	14:20

D. Eddy
Technician(s)

12-17-01
Date

5.0 High Voltage Harness Test

Completed

5.1 Interlock line test. ☑
Pushbutton switch is normally open. Push down switch and check by multimeter Resistance between lines 31 and 36 on the patch panel.
Pass: less than 5 Ohm at push down switch position

Interlock schematic Layout tests	Pass	Fail
	✓	

5.2 HV harness schematic layout test ☑
Connect patch panel to HV power supply, set 30 V and put voltage to each HV segment one by one. Measure voltage on the chamber segment.

Schematic Layout test	Pass (30 V)	Fail (no voltage)
	✓	

5.3 HV test of harness ☑
Connect patch panel to HV power supply, set 4.0 kV and put voltage to all HV Segments on the chamber. Measure current on the HV power supply. Record data into table below.

Note(s):

HV chamber jumpers will be disconnected. It is extremely important.

High voltage, kV	Current, nA	Time, start	Time, stop	Humidity	Temperature
4.0 kV	40	13:25	—	31%	72.5
4.0 kV	9	—	13:35	31%	72.5

5.3.1 Criteria of good harness: current at 4.0 kV after 10 min. will be less 30 nA. ☑

Pass	Fail
✓	

Comments:

5.4 Connect chamber HV jumper to harness (switchboard terminal on the red channel) and start chamber HV test and training. ☑

D. Eddy
Technician(s)

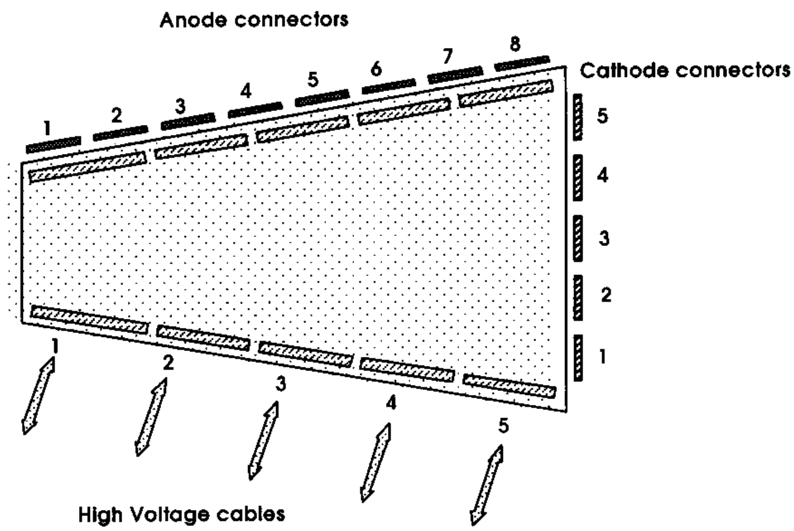
12-19-01
Date

6.0 Chamber High voltage test.

Note(s):

Be sure that before starting High Voltage tests the chamber was purged with working gas mixture at least 48 hours.

6.1 Connect chamber to the High Voltage power supply (Model 6900). ☑



6.2 Raise slowly High Voltage up to 4.0 kV (up to 15 minutes per voltage step).
Record current data from the chamber to the table.
Record the current from each plane for 3.6 kV and 4.0 kV **if** the Chamber current is higher than 1 μA

	Chamber All Panels	Time		Plane #					
				1	2	3	4	5	6
HV KV	**I μA**	**Start/ Stop**	**Date**	**I μA**	**I μA**	**I μA**	**I μA**	**I μA**	**I μA**
1.0	0.1	13:39	12/19						
2.0	0.1	13:41	—						
3.0	0.1	13:44	—						
3.2	0.1	13:46	—						
3.4	0.2	13:48	—						
3.6	0.4	13:50	—						
3.7	0.6	13:52	—						
3.8	.0.8	13:54	—						
3.9	1.8	15:56	—						
4.0	4.0	13:58	12/19			SEG5-1.6	SEG5-1.0		SEG2-1.0

Remarks: ____________________

Note(s):

In case of corona or high current more than 5.0 μA per plane:
specify and disconnect High Voltage Segment
continue raise High Voltage in accordance with procedure

D. Eddy
Technician(s)

12-19-01
Date

7.0 Chamber High Voltage Training With Reverse Polarity

Completed

7.1 Connect chamber to the High Voltage power supply with reverse polarity (Model 5900). ☑

7.2 Slowly raise the High Voltage up to 3.3 kV (Current must be less than 30-50 μA.). ☑
Keep the Chamber at 3.3 kV for 20-30 minutes or until the current drops to zero.
Record current data from the chamber to the table.
Record the current from each plane for 3.3 kV.

Note(s):

Don't keep Chamber under reverse High Voltage more than 1 hour.

Reverse Polarity Test #1

	Chamber All Panels	Time		Plane #					
				1	2	3	4	5	6
HV KV	I μA	Start/ Stop	Date	I μA	I μA	I μA	I μA	I μA	I μA
2.4	0.2	14:10	12/19						
2.5	0.2	14:12	—						
2.6	0.2	14:14	—						
2.7	0.2	14:17	—						
2.8	0.2	14:20	—						
2.9	0.2	14:22	—						
3.0	0.2	14:24	—						
3.1	4.0	14:26	—						
3.2	6.0	14:28	—						
3.3	4.0	15:00	12/19			SEG 1-3.0			

Remarks:

D. Eddy
Technician(s)

12-19-01
Date

8.0 Re-testing/Re-Training of Chamber

8.1 Re-test the Chamber by slowly raising the High Voltage up to 4.0 kV (up to 15 minutes per voltage step). Record current data from the chamber to the table.
Record the current from each plane for 3.6 kV and 4.0 kV **if** the Chamber current is higher than 1 μA

	Chamber All Panels	Time		Plane #					
				1	2	3	4	5	6
HV KV	I μA	Start/ Stop	Date	I μA	I μA	I μA	I μA	I μA	I μA
1.0	0.1	15:18	12/19						
2.0	0.1	15:20	—						
3.0	0.1	15 22	—						
3.2	0.2	15:24	—						
3.4	0.2	15 27	—						
3.6	0.2	15:30	—						
3.7	0.2	15:32	—						
3.8	0.2	15 34	—						
3.9	0.25	15 36	—						
4.0	0.3	15:38	12/19						

Remarks:

Note(s):

In case of corona or high current more than 5.0 μA per plane:
specify and disconnect High Voltage Segment
continue raise High Voltage in accordance with procedure

D. Eddy
Technician(s)

12-19-01
Date

Completed

8.2 Perform 2nd Reverse Polarity test ONLY if discrepancies occurred in step 7.1. ❒

Note(s):

A discrepancy occurs when the current for some segment exceeds 1.0 µA

8.2.1 Connect chamber to the High Voltage power supply with reverse polarity. ❒

8.2.2 Slowly raise the High Voltage up to 3.3 kV (Current must be less than 30-50 µA.). ❒
Keep the Chamber at 3.3 kV for 20-30 minutes or until the current drops to zero.
Record current data from the chamber to the table.
Record the current from each plane for 3.3 kV.

Note(s):

Don't keep Chamber under reverse High Voltage more than 1 hour.

Reverse Polarity Test #2

	Chamber All Panels	Time		Plane #					
				1	2	3	4	5	6
HV kV	**I µA**	**Start/ Stop**	**Date**	**I µA**	**I µA**	**I µA**	**I µA**	**I µA**	**I µA**
2.4									
2.5									
2.6									
2.7									
2.8									
2.9									
3.0									
3.1									
3.2									
3.3									

Remarks:____________________

D. Eddy
Technician(s)

12-21-01
Date

9.0 Chamber High voltage training with normal polarity.

Completed

9.1 Connect chamber to the High Voltage power supply with normal polarity. ☑

9.2 Slowly raise the High Voltage up to 3.8-4.0 kV until the Chamber current reaches between 1.0-2.0μA. ☑

9.3 Start the training procedure. Keep the chamber under high voltage for 1-2 days until the current drops to 0.1 μA or less per plane. Increase High Voltage for 0.1kV and continue chamber training.
Record current data from the chamber to the table. ☑

	Chamber All Panels	Time		Plane #					
				1	2	3	4	5	6
HV KV	I μA	Start/ Stop	Date	I μA	I μA	I μA	I μA	I μA	I μA
4.0	0.3	15:40	12/19						
4.0	0.25	7:45	12/20	SWITCHED TO # 1 POWER SUPPLY					
4.0	0.15	8:00	12/21						
4.0	0.20	15:30	12/21	CHAMBER PASSES H/V TESTING					

Remarks:

D. Eddy
Technician(s)

12-21-01
Date

9.4 Keep chamber at 4.0 kV at least 24 hours.
Record data into table.

	Chamber All Panels	Time		Plane #					
				1	2	3	4	5	6
HV KV	I μA	Start/ Stop	Date	I μA	I μA	I μA	I μA	I μA	I μA
4.0									
4.0									
4.0									
4.0									
4.0									
4.0									
4.0									
4.0									
4.0									
4.0									

Note(s):

Criterion of the good chamber:

-Current less than 0.1μA per plane for 24 hours.
-No current trip at 10μA trip set for 24 hours.
-No Corona Signals.

9.5 Once the Chamber is acceptable, record the final current from each plane at 4.0 kV in the chart below.

KV	Chamber Current	Plane #						Time	Date
		1	2	3	4	5	6		
4.0	0.2	.03	.04	.04	.04	.03	.04	15:30	12-21-01

Technician(s): D. Eddy

Date: 12-21-01

10.0 Chamber Cosmic Test

Completed

10.1 Connect the Scope to the protection board. ☑

10.2 Check anode signals from all anode protection boards. ☑

Note(s):

After measurements are completed inform supervisor if any signals are missing or any Corona signals are present from anode protection boards.

10.3 The Chamber has passed the High Voltage Test and Training and meets the criterion for a good Chamber based on the Note(s) below step 8.4. ☑

D. Eddy
Technician(s)

12-21-01
Date

11.0 Chamber Final

Completed

11.1 Install Z-Brackets onto the Wide End (368043, 368044, 368058 and 368059 [Qty. 2 complete brackets]) and Narrow End (368045 and 368060 [Qty. 1 complete bracket]). ☑

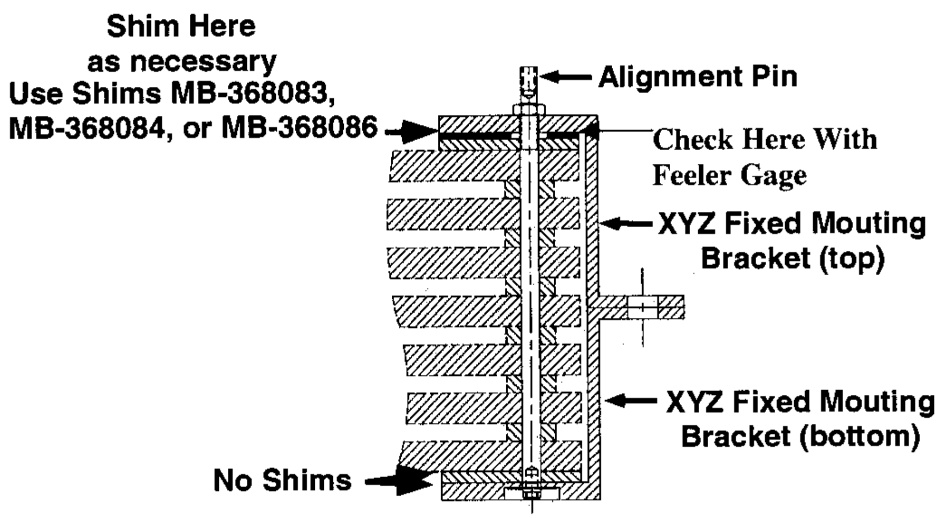
11.2 Screw the Z-Brackets together with Flat Head Screws (368077). ☑

11.3 On the Narrow end, fill the gap between the top Z-Bracket and the Frame Extrusion with the three slotted Shims according to Dwg. ME-368229 and drawing below. ☑

Note(s):

Shims are to be installed ONLY on the TOPSIDE of the Chamber.

11.4 Once the gap is almost filled in, use the Feeler Gauge to determine the correct size of the last Shim. Use the Shim with the closest width to the measurement. ☑



Chamber Narrow End
Side view of Center

11.5 Once the correct size Shims have been determined, record which size Shims were used in the chart below.

Narrow End Z-Bracket Shims Used
50
50
30
20

G. Eddy
Technician(s)

1-08-02
Date

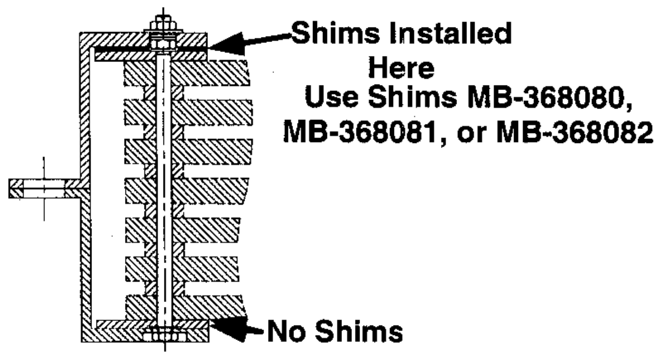
Completed

11.6 On the Wide end, fill the gap between the top Z-Brackets and the Frame Extrusion with the two slotted Shims according to Dwg. ME-368229 and drawing below. ☑

Note(s):

Shims are to be installed ONLY on the TOPSIDE of the Chamber.

11.7 Once the gap is almost filled in, use the Feeler Gauge to determine the correct size of the last Shim. Use the Shim with the closest width to the measurement. ☑



Chamber End View (Wide End)

11.8 After Z-Brackets and shims are assembled, check the measurement with a feeler gage. The measurement will be less then 4 mils. ☑

11.9 Install the Big End Plates (368074) onto the outer edges of the Wide End according to Dwg. ME-368229. ☑

11.10 Once the correct size Shims have been determined, record which size Shims were used on each corner Z-Bracket in the chart below.

Wide End Z-Bracket Shims Used	
High Voltage Side	**Anode Side**
50	50
50	50
30	30
20	20

D. Eddy
Technician(s)

1-08-02
Date

Completed

11.11 On top of Chamber, place approximately three Flat Washers (368056) into each of the recessed holes of the Z-Brackets so they are just below flush. Then place one Washer (368010) over those followed by one Hex Nut (368039). ☑

11.12 With the washers and nuts attached to the top of the panel, thread one Hex Nut (368039) onto the bottom side of the bolts and torque the bottom nut to 50 to 60 inch pounds first, and then reverse and torque the top nut also to 50-60 inch pounds. ☑

11.13 Attach the Snap Rings (368018 [Qty. 2]) to the Alignment Bolts, one on the Wide End, and one on the Narrow End. ☑

Note(s):

The Snap Ring on the Wide End goes into the SECOND groove from the bottom end of the Pin, and the Snap Ring on the Narrow End goes into the first groove from the bottom end of the Pin.

11.14 Torque the Jam Nut (368055) on both Alignment Pins to 25 inch pounds. ☑

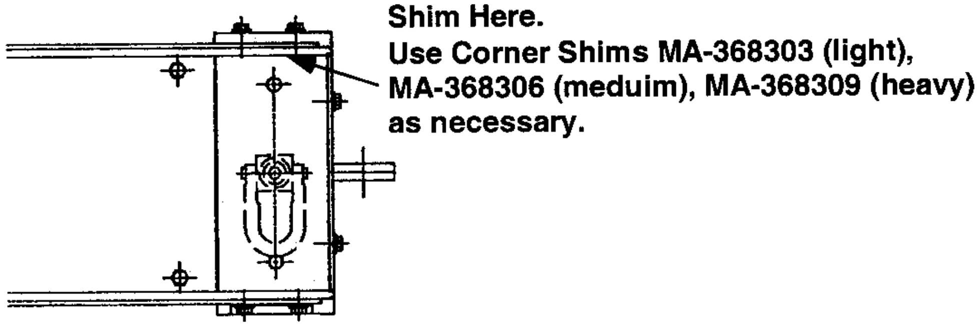
11.15 Install the Small End Plates (368075) onto the outer edges of the Narrow End according to Dwg ME-368229. ☑

11.16 Fill the gap between the top of the small End Plates and the Frame Extrusions with the Shims according to Dwg. ME-368229 and drawing below. ☑

Note(s):

Shims are to be installed ONLY on the TOPSIDE of the Chamber.

11.17 Once the gap is almost filled in, use the Feeler Gauge to determine the correct size of the last Shim. Use the Shim with the closest width to the measurement. ☑



Chamber Corner, Side View

Completed

11.18 Once the correct size Shims have been determined, record which size Shims were used on each corner in the chart below.

Chamber Corner Shims Used	
Narrow End	
High Voltage Side	**Anode Side**
—	—

G. Eddy
Technician(s)

1-08-02
Date

11.19 Install the Narrow End Side Panels (368071) into the Narrow End, on each side of the Z-Bracket. ☑

11.20 Attach the High Voltage Side Panel (368072) onto High Voltage Side. ☑

11.21 Apply one Avery label with the chamber number, in the middle of the wide end panel. Apply one Avery label with the chamber number, below the push button switch on the high voltage side panel. ☑

G. Eddy
Technician(s)

1-08-02
Date

X 11.22 Affix the completed Generic Magnet Identification Label (MA-318490) (Qty. 1) on the chamber as per ME234/2 EndCap Muon Chamber Final Assy drawing ME-368220. Affix a completed Generic Magnet Identification Label (MA-318490)(Qty 1) to this page below.

Fermi National Accelerator Laboratory
Technical Division

CMS - Muon Endcap

Endcap Muon Chamber (ME234/2)

Chamber SN: ME234/2-067-0 **Drawing No.:** ME-368220

Weight (Lbs):	700	**Metric Weight (KG):**	317.5
Length (In):	136.53	**Metric Length (CM):**	346.8
Width (In):	59.60	**Metric Width (CM):**	151.4
Height (In):	8.93	**Metric Height (CM):**	22.7

Date Completed: 1/8/2002

Pamela Blan
Inspector

1/8/02
Date

12.0 Production Complete

XXX 12.1 Process Engineering verify that the Electrical Test / HV Test and Training (5520-TR-3332) is accurate and complete. This shall include a review of all steps to ensure that all operations have been completed and signed off. Ensure that all Discrepancy Reports, Nonconformance Reports, Repair/Rework Forms, Deviation Index and dispositions have been reviewed by the Responsible Authority for conformance before being approved.

Comments:

Pamela Bhon
Process Engineering/Designee

1/11/02
Date

Fermi National Accelerator Laboratory
Batavia, IL 60510

CMS ME234/2 CHAMBER PACKAGING AND SHIPMENT TRAVELER

Reference Drawing(s)
Chamber Shipping Stack Set
5520-MC-368680
Endcap Muon Chamber ME234/2 Final Assembly
5520-ME-368220

Budget Code:	**Project Code:**
Released by: Pamela Pihon	**Date:** SEP 07 2001
Prepared by:, B. Jensen, P. Isham	

Title	Signature	Date
TD / E&F Process Engineering	Bob Jensen Bob Jensen/Designee	5/8/01
TD / E&F CMS Assembly	Glenn Smith Glenn Smith/Designee	5/8/01
TD / E&F Technological Physicist	Oleg Prokofiev/Designee	5/8/01
TD / CMS Project Manager	Apollinari Giorgio Apollinari/Designee	5/11/01

Revision Page

Revision	Step No.	Revision Description	TRR No.	Date
None	N/A	Initial Release	N/A	04/12/01
A	3.7	Changed 3.6-3.8 to 3.4-3.6.	1159	5/8/01
	4.7,5.7, 6.7,7.7 8.7	Added fold the long side.		
	4.9,5.9 6.9,7.9 8.9	Removed in the middle and added 46-48 inches in from the narrow end.		
	4.10,5.10 6.10,7.10 8.10	Moved to step 3.8.		

Ensure appropriate memos and specific instructions are placed with the traveler before issuing the sub traveler binder to production.

1.0 General Notes

1.1 White (Lint Free) Gloves (Fermi stock 2250-1800) or Nitrile Gloves (Fermi stock 2250-2040) shall be worn by all personnel when handling all product parts after the parts have been prepared/cleaned.

1.2 All steps that require a sign-off shall include the Technician/Inspectors first initial and full last name.

1.3 No erasures or white out will be permitted to any documentation. All incorrectly entered data shall be corrected by placing a single line through the error, initial and date the error before adding the correct data.

1.4 All Discrepancy Reports issued shall be recorded in the left margin next to the applicable step.

1.5 All personnel performing steps in this traveler must have documented training for this traveler and associated operating procedures.

1.6 Personnel shall perform all tasks in accordance with current applicable ES&H guidelines and those specified within the step.

1.7 Cover the panel/chamber with Mylar when not being serviced or assembled.

2.0 Parts Kit List

2.1 No Parts Kit Required for this Operations

3.0 Chamber Preparation

Completed

3.1 Select five Chambers (ME-368220) for shipment, and then record the chamber numbers in the chart below. ☑

		SERIAL NUMBER
Top Chamber	Chamber #5	ME234/2- 003
	Chamber #4	ME234/2- 048
	Chamber #3	ME234/2- 045
	Chamber #2	ME234/2- 010
Base Chamber	Chamber #1	ME234/2- 047

3.2 Verify that the completed Endcap Muon Chamber Identification Label (MA-318490)(Qty.1) is on the chambers as per ME234/2 EndCap Muon Chamber Final Assy drawing ME-368220. ☑

3.3 Verify that all the shims are on each chamber, and the Anode side panel small holes are facing up, and place the red cap on the gas inlet tube. Check the appropriate box below. ☑

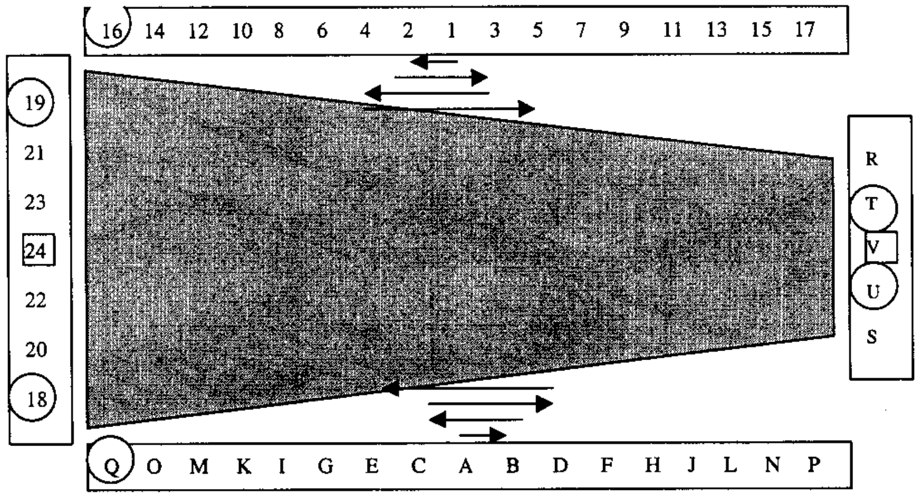
	Narrow and Wide End Shims	Anode Side Panel Small Holes are Facing Up	Red Cap on Gas Inlet Tube
Chamber #5	X	X	X
Chamber #4	X	X	X
Chamber #3	X	X	X
Chamber #2	X	X	X
Chamber #1	X	X	X

Technician(s): Al. Battelin [signature]

Date: 9-17-01

Completed

3.4 Check to ensure that all the bolts are torqued to 55 inch pounds, except the bolts with a circle or square (bolts 16, 18, 19, 24, Q, T, U and V) in below diagram. ☑



3.5 Check to ensure that the alignment bolts (24, V) are torqued at 25 inch pounds. ☑

3.6 Use the tooling that is provided to align the Z-Bracket on the narrow and wide end of the chamber. After the brackets are align, ensure that the Z-Bracket bolts are torqued at 50-60 inch pounds ☑

3.7 After all bolts have been re-torqued, check the appropriate box below, indicating that each chamber has been checked and reworked as per steps 3.4 - 3.6. ☑

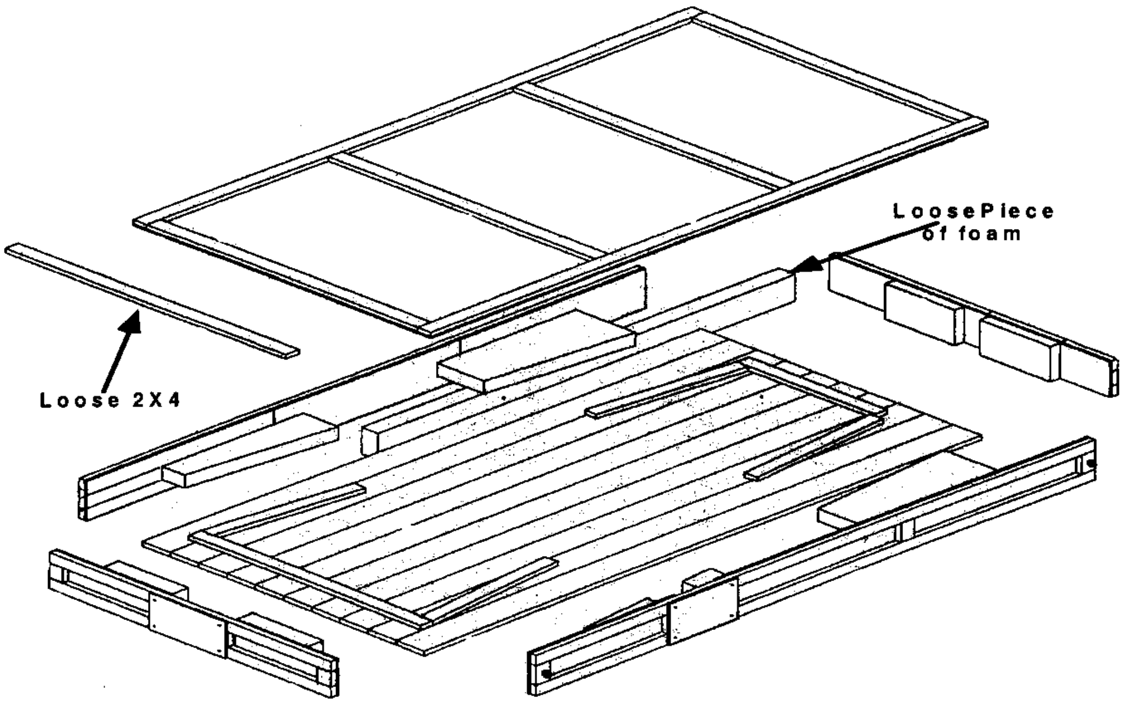
Chamber #5 ☑
Chamber #4 ☑
Chamber #3 ☑
Chamber #2 ☑
Chamber #1 ☑

3.8 Verify that baggie with the HV switch cover and two screws are taped to the top of the chamber. ☑

[illegible] ____________ 9-17-01 ____________
Technician(s) Date

4.0 Chamber Shipping Box Preparation/Assembly #1

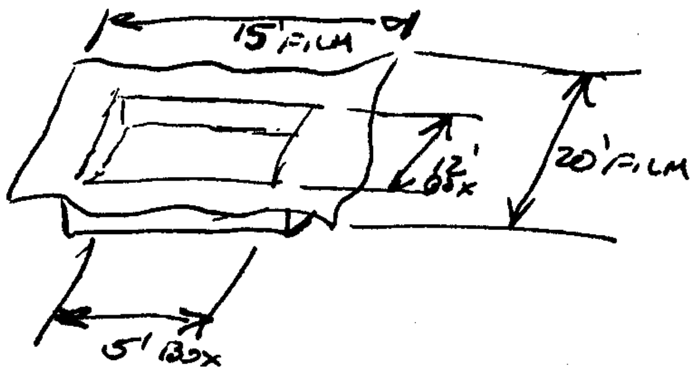
Completed



4.1	Transport the chamber shipping box (MC-368681) by approved methods to the packing assy area.	☑
4.2	Remove the lid, then verify and remove the (2 x 4') loose piece of wood from the chamber shipping box, and the loose piece of foam.	☑
4.3	Verify that the precut foam pads are provided and in the correct position.	☑
4.4	Check the chamber shipping box to make sure that the inside is clean if needed vacuum the dust and the dirt from the container.	☑

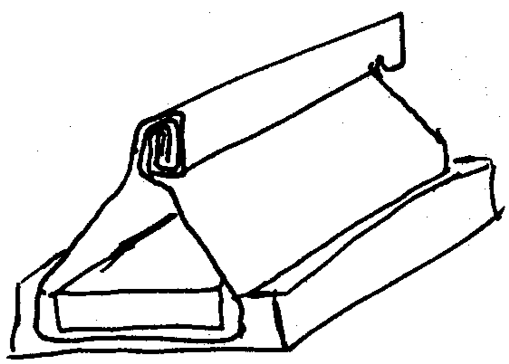
Completed

4.5 Push the anti-static film (VCI 126; 4mil; 15' x 20') into the box opening, where the ends of the anti-static film lay over the sides of the box. See diagram below. ☑

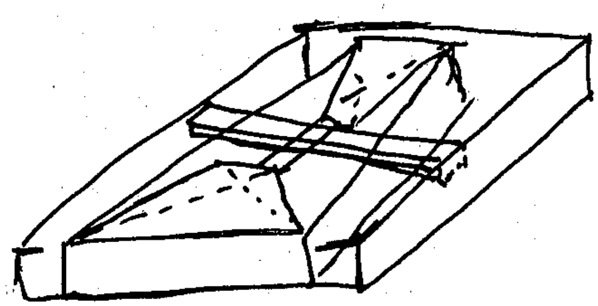


4.6 Attach the straps to the chamber lifting eyes in the four chamber corners, and use the approved method to pick up the chamber and carefully lower it in the chamber shipping box. ☑

4.7 After the chamber is in the shipping box, fold the long sides of the anti-static film over the chamber and secure it with green duct tape see diagram below. ☑



4.8 Fold the ends of the anti-static film over and secure with green duct tape to the chamber as per diagram below. ☑



Shipping Stack Set No. 007
ME234/2-045

Completed

4.9 Place the loose foam filler pieces into position along the anode side of the chamber: Attach the 2 x 4 (46 - 48 inches) in from the narrow end, across the top of the box in the widthwise direction and secure with the provided screws. Applied from the inside of the box. See diagram below. ☑

4.10 Carefully place the lid over the chamber box and secure with the screws that are supplied. ☑

M. Battista
Technician(s)

9-17-01
Date

5.0 Chamber Shipping Box Preparation/Assembly #2

Completed

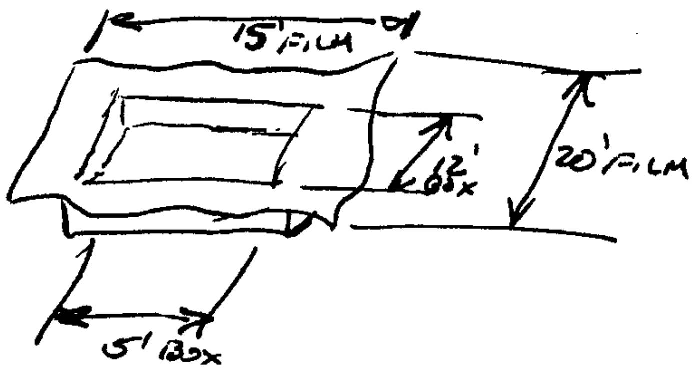
5.1 Transport the chamber shipping box (MC-368681) by approved methods to the packing assy area. ☑

5.2 Remove the lid, then verify and remove the two (2 x 4's) loose pieces of wood from the chamber shipping box. ☑

5.3 Verify that the precut foam pads are provided and in the correct position. ☑

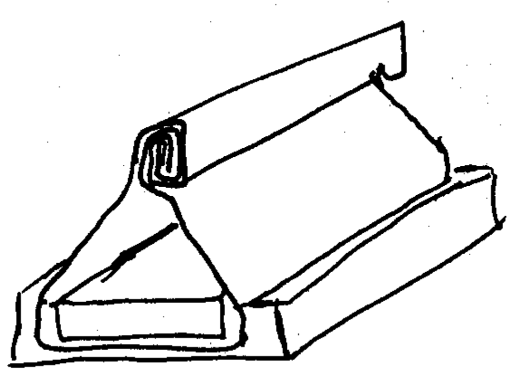
5.4 Check the chamber shipping box to make sure that the inside is clean if needed vacuum the dust and the dirt from the container. ☑

5.5 Push the anti-static film (VCI 126; 4mil; 15' x 20') into the box opening, where the ends of the anti-static film lay over the sides of the box. See diagram below. ☑



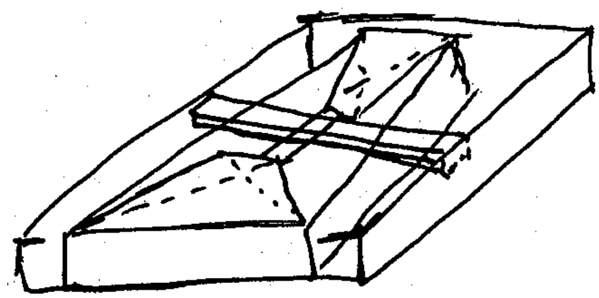
5.6 Attach the straps to the chamber lifting eyes in the four chamber corners, and use the approved method to pick up the chamber and carefully lower it in the chamber shipping box. ☑

5.7 After the chamber is in the shipping box, fold the long sides of the anti-static film over the chamber and secure it with green duct tape see diagram below. ☑

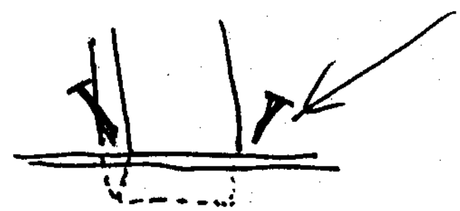


Completed

5.8 Fold the ends of the anti-static film over and secure with green duct tape to the chamber as per diagram below.



5.9 Place the loose foam filler pieces into position along the anode side of the chamber: Attach the 2 x 4 (46 - 48 inches) in from the narrow end, across the top of the box in the widthwise direction and secure with the provided screws. Applied from the inside of the box. See diagram below.



5.10 Carefully place the lid over the chamber box and secure with the screws that are supplied.

Al Battista
Technician(s)

9-17-01
Date

6.0 Chamber Shipping Box Preparation/Assembly #3

Completed

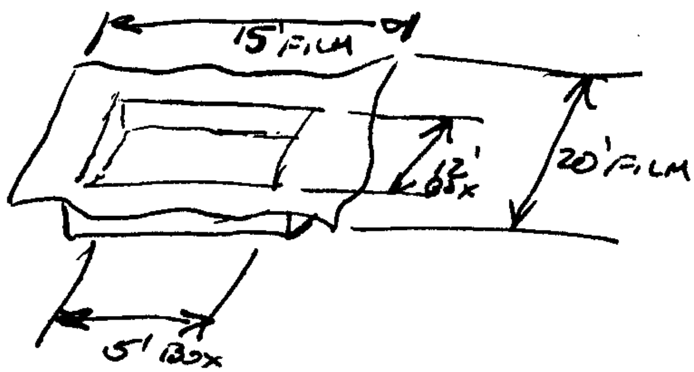
6.1 Transport the chamber shipping box (MC-368681) by approved methods to the packing assy area.

6.2 Remove the lid, then verify and remove the two (2 x 4's) loose pieces of wood from the chamber shipping box.

6.3 Verify that the precut foam pads are provided and in the correct position.

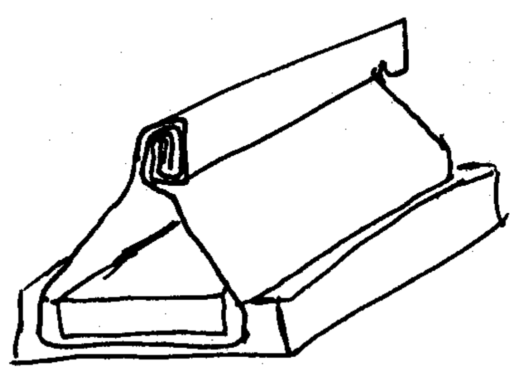
6.4 Check the chamber shipping box to make sure that the inside is clean, if needed vacuum the dust and the dirt from the container.

6.5 Push the anti-static film (VCI 126; 4mil; 15' x 20') into the box opening, where the ends of the anti-static film lay over the sides of the box. See diagram below.



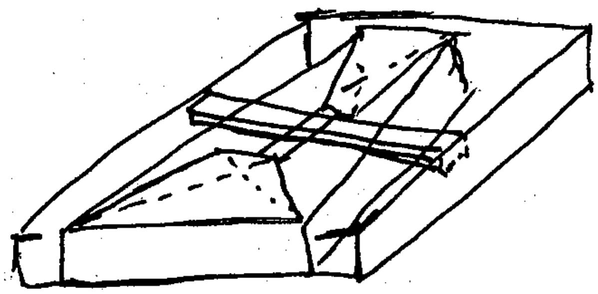
6.6 Attach the straps to the chamber lifting eyes in the four chamber corners, and use the approved method to pick up the chamber and carefully lower it in the chamber shipping box.

6.7 After the chamber is in the shipping box, fold the long sides of the anti-static film over the chamber and secure it with green duct tape see diagram below.

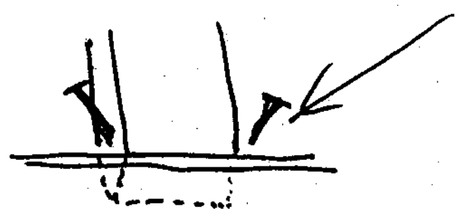


Completed

6.8 Fold the ends of the anti-static film over and secure with green duct tape to the chamber as per diagram below. ☑



6.9 Place the loose foam filler pieces into position along the anode side of the chamber: Attach the 2 x 4 (46 - 48 inches) in from the narrow end, across the top of the box in the widthwise direction and secure with the provided screws. Applied from the inside of the box. See diagram below. ☑



6.10 Carefully ~~place the~~ lid over the chamber box and secure with the screws that are supplied. ☑

Technician(s) [signature]   Date 9-17-01

7.0 Chamber Shipping Box Preparation/Assembly #4

Completed

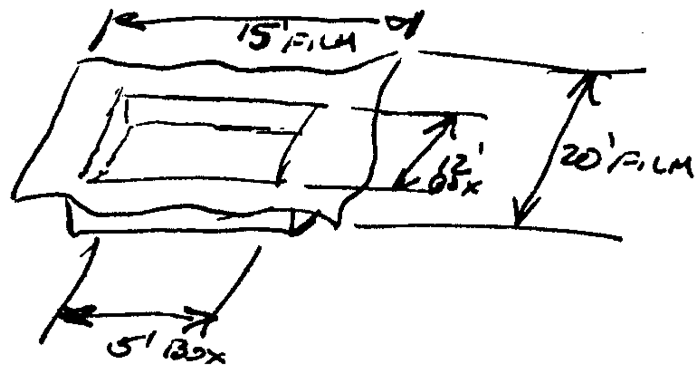
7.1 Transport the chamber shipping box (MC-368681) by approved methods to the packing assy area.

7.2 Remove the lid, then verify and remove the two (2 x 4's) loose pieces of wood from the chamber shipping box.

7.3 Verify that the precut foam pads are provided and in the correct position.

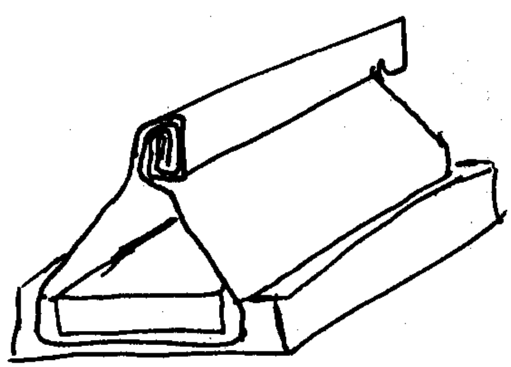
7.4 Check the chamber shipping box to make sure that the inside is clean, if needed vacuum the dust and the dirt from the container.

7.5 Push the anti-static film (VCI 126; 4mil; 15' x 20') into the box opening, where the ends of the anti-static film lay over the sides of the box. See diagram below.



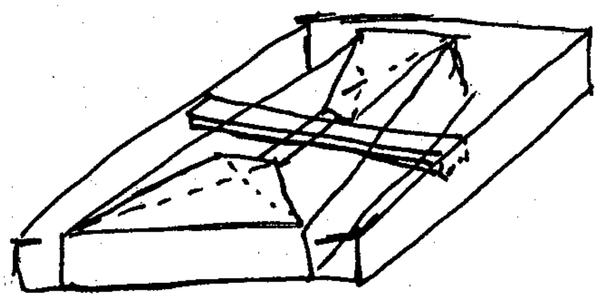
7.6 Attach the straps to the chamber lifting eyes in the four chamber corners, and use the approved method to pick up the chamber and carefully lower it in the chamber shipping box.

7.7 After the chamber is in the shipping box, fold the long sides of the anti-static film over the chamber and secure it with green duct tape see diagram below.



Completed

7.8 Fold the ends of the anti-static film over and secure with green duct tape to the chamber as per diagram below. ☑



7.9 Place the loose foam filler pieces into position along the anode side of the chamber: Attach the 2 x 4 (46 - 48 inches) in from the narrow end, across the top of the box in the widthwise direction and secure with the provided screws. Applied from the inside of the box. See diagram below. ☑

7.10 Carefully place the lid over the chamber box and secure with the screws that are supplied. ☑

R. Batlsler
Technician(s)

9-17-01
Date

8.0 <u>Chamber Shipping Box Preparation/Assembly #5</u>

Completed

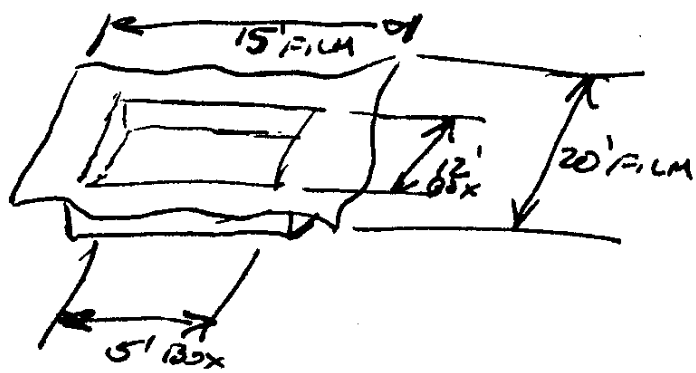
8.1 Transport the chamber shipping box (MC-368681) by approved methods to the packing assy area. ☒

8.2 Remove the lid, then verify and remove the two (2 x 4's) loose pieces of wood from the chamber shipping box. ☒

8.3 Verify that the precut foam pads are provided and in the correct position. ☒

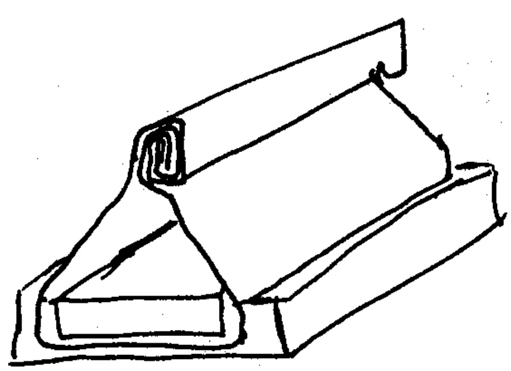
8.4 Check the chamber shipping box to make sure that the inside is clean, if needed vacuum the dust and the dirt from the chamber shipping box. ☒

8.5 Push the anti-static film (VCI 126; 4mil; 15' x 20') into the box opening, where the ends of the anti-static film lay over the sides of the box. See diagram below. ☒



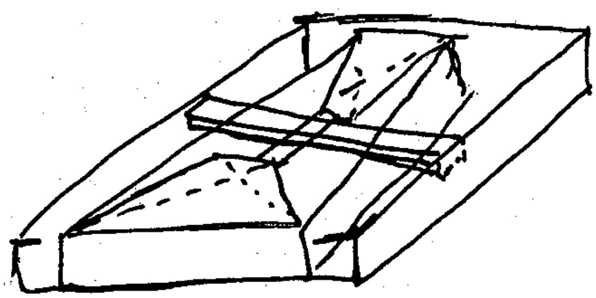
8.6 Attach the straps to the chamber lifting eyes in the four chamber corners, and use the approved method to pick up the chamber and carefully lower it in the chamber shipping box. ☒

8.7 After the chamber is in the shipping box, fold the long sides of the anti-static film over the chamber and secure it with green duct tape see diagram below. ☒

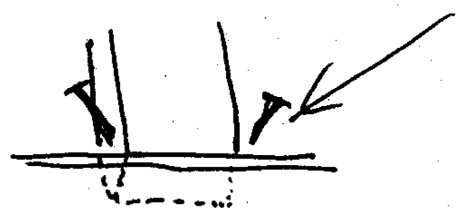


Completed

8.8 Fold the ends of the anti-static film over and secure with green duct tape to the chamber as per diagram below. ☒



8.9 Place the loose foam filler pieces into position along the anode side of the chamber: Attach the 2 x 4 (46 - 48 inches) in from the narrow end, across the top of the box in the widthwise direction and secure with the provided screws. Applied from the inside of the box. See diagram below. ☒



8.10 Inspect lifting rings to ensure there is no damage to them. ☒

8.11 Include one set (4) of lifting rings with every five chambers, and leave them in the chamber. ☒

8.12 Send a copy of the Chamber Assembly and Chamber Electrical travelers of each chamber with the stack set. ☒

8.13 Carefully place the lid over the chamber shipping box and secure with the screws that is supplied. ☒

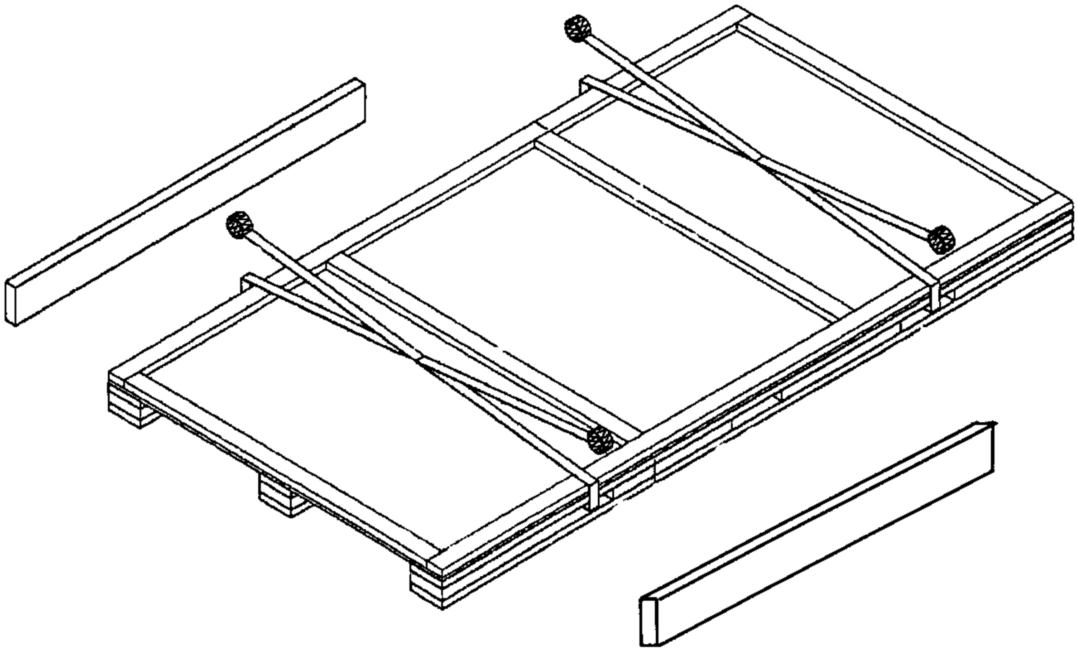
M. Battista
Technician(s)

9-17-01
Date

9.0 Stack Set Assembly/Shipping

Completed

9.1 Prepare the chamber-stacking skid (MC-368682) . Unfold the skid slings so the are out of the way of loading of the chamber shipping boxes.



9.2 Stack the five chamber shipping boxes with shipping box #1 in the base position and shipping box #5 in the top position, using slings and the provided chamber lifting eyes.

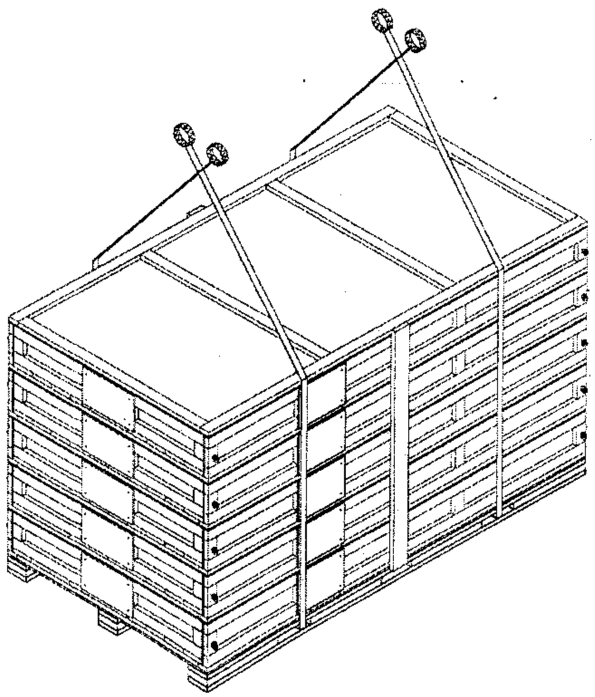
Note(s):

All chamber shipping boxes must be stacked so that the shipping box windows are all on the same sides. (See picture @ Step 9.4).

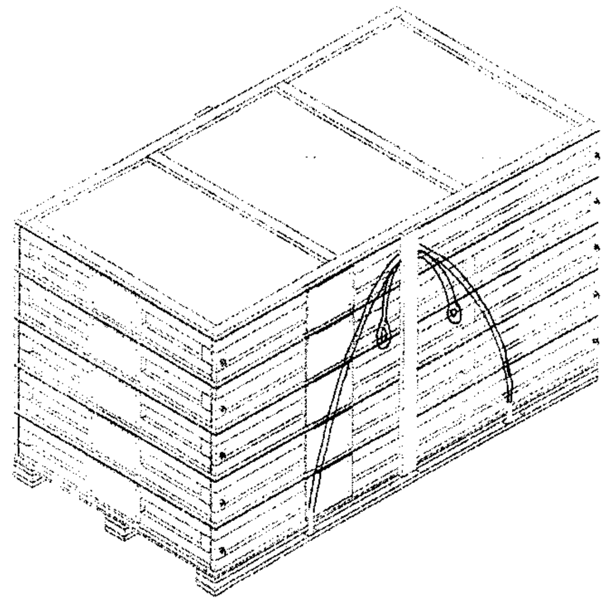
9.3 Once all the chamber shipping boxes are stacked together, attach the two 2 x 6's that are provided to center of the sides of the stack. Secure the 2x6's to the skid on the bottom and the top of the chamber lid using the screws that are provided.

Completed

9.4 Using the provided slings load the stack set of 5 chamber shipping boxes onto the truck. Once on the truck, tuck the four sling straps behind and around the 2 x 6's at the top chamber shipping.box and secure slings and sling ends to prevent damage during shipping. AB



Shown with Slings in Lifting Mode



Shown with Slings in Transport Mode

9.5 In the chart below record where the stack set will be transported to.

	Stack Set Serial Number
University of Florida	
UCLA X	007
Other	

A. Baltzler
Technician(s)

9-17-01
Date

10.0 Production Complete

XXX 10.1 Process Engineering verify that the Chamber Packaging and Shipment (5520-TR-333256) is accurate and complete. This shall include a review of all steps to ensure that all operations have been completed and signed off. Ensure that all Discrepancy Reports, Nonconformance Reports, Repair/Rework Forms, Deviation Index and dispositions have been reviewed by the Responsible Authority for conformance before being approved.

Comments:

Pamela Fisher
Process Engineering/Designee

9/17/01
Date

Fermi National Accelerator Laboratory
Batavia, IL 60510

CMS ME234/2 CHAMBER PACKAGING AND SHIPMENT TRAVELER

Reference Drawing(s)

Chamber Shipping Stack Set
5520-MC-368680

Endcap Muon Chamber ME234/2 Final Assembly
5520-ME-368220

Magnet/Device Series: ME234/2	
Budget Code:	**Project Code:**
Released by: Pamela Bloom	**Date:** DEC 17 2001
Date Closed: 1/23/02	**Scan Pages:** 21
Prepared by: B. Jensen, M. Hubbard, L. Lee, P. Isham	

Title	Signature	Date
TD / E&F Process Engineering	Bob Jensen/Designee	11/8/01
TD / E&F CMS Assembly	Glenn Smith/Designee	11/08/01
TD / E&F Technological Physicist	Oleg Prokofiev/Designee	11/08/01
TD / E&F CMS Project Manager	Giorgio Apollinari/Designee	11/08/01

Revision Page

Revision	Step No.	Revision Description	TRR No.	Date
None	N/A	Initial Release	N/A	04/12/01
A	3.7	Changed 3.6-3.8 to 3.4-3.6.	1159	5/8/01
	4.7,5.7, 6.7,7.7 8.7	Added fold the long side.		
	4.9,5.9 6.9,7.9 8.9	Removed in the middle and added 46-48 inches in from the narrow end.		
	4.10,5.10 6.10,7.10 8.10	Moved to step 3.8.		
B	CVRPG	Added magnet device, date closed, scanned pages to the cover sheet, and serial number prefix to the bottom of the cover sheet.	1277	10/24/01
C	CVRPG	Added serial number prefix.	1287	11/08/01
	2.1	Added part kits list to the traveler.		

Ensure appropriate memos and specific instructions are placed with the traveler before issuing the sub traveler binder to production.

1.0 General Notes

1.1 White (Lint Free) Gloves (Fermi stock 2250-1800) or Nitrile Gloves (Fermi stock 2250-2040) shall be worn by all personnel when handling all product parts after the parts have been prepared/cleaned.

1.2 All steps that require a sign-off shall include the Technician/Inspectors first initial and full last name.

1.3 No erasures or white out will be permitted to any documentation. All incorrectly entered data shall be corrected by placing a single line through the error, initial and date the error before adding the correct data.

1.4 All Discrepancy Reports issued shall be recorded in the left margin next to the applicable step.

1.5 All personnel performing steps in this traveler must have documented training for this traveler and associated operating procedures.

1.6 Personnel shall perform all tasks in accordance with current applicable ES&H guidelines and those specified within the step.

1.7 Cover the panel/chamber with Mylar when not being serviced or assembled.

2.0 Parts Kit List

2.1 Attach the completed Parts Kit for this production operation to this traveler.
Ensure that the serial number on the Parts Kit matches the serial number of this traveler.
Verify that the Parts Kit received is complete.

Pamela Ebon DEC 17 2001

Process Engineering/Designee Date

Received with add'l parts request on 11/6/01.
Add'l parts request is in the back of the traveler.

3.0 Chamber Preparation

Completed

3.1 Select five Chambers (ME-368220) for shipment, and then record the chamber numbers in the chart below. ☑

SERIAL NUMBER

Top Chamber	**Chamber #5**	**ME234/2-** 069
	Chamber #4	**ME234/2-** 067
	Chamber #3	**ME234/2-** 066
	Chamber #2	**ME234/2-** 064
Base Chamber	**Chamber #1**	**ME234/2-** 065

3.2 Verify that the completed Endcap Muon Chamber Identification Label (MA-318490)(Qty.1) is on the chambers as per ME234/2 EndCap Muon Chamber Final Assy drawing ME-368220. ☑

3.3 Verify that all the shims are on each chamber, and the Anode side panel small holes are facing up, and place the red cap on the gas inlet tube. Check the appropriate box below. ☑

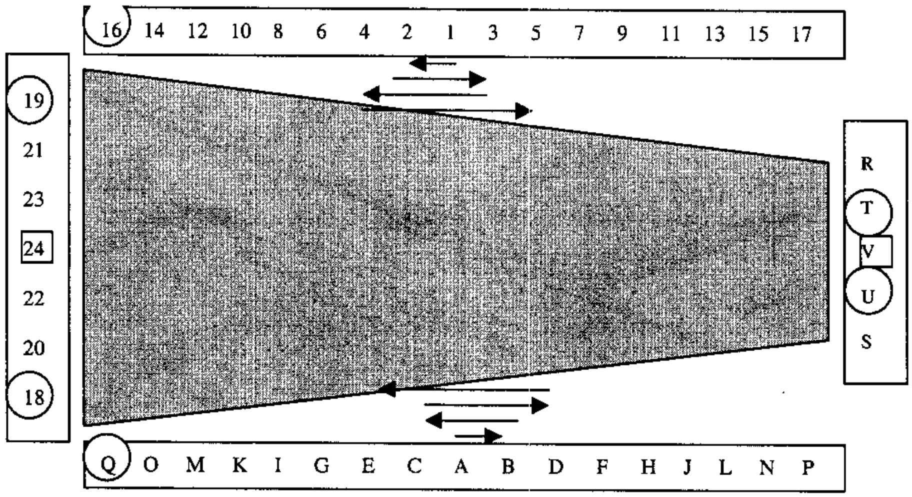
	Narrow and Wide End Shims	Anode Side Panel Small Holes are Facing Up	Red Cap on Gas Inlet Tube
Chamber #5	✓	✓	✓
Chamber #4	✓	✓	✓
Chamber #3	✓	✓	✓
Chamber #2	✓	✓	✓
Chamber #1	✓	✓	✓

[illegible signature]
Technician(s)

12-18-01
Date

Completed

3.4 Check to ensure that all the bolts are torqued to 55 inch pounds, except the bolts with a circle or square (bolts 16, 18, 19, 24, Q, T, U and V) in below diagram. ☑



3.5 Check to ensure that the alignment bolts (24, V) is torqued at 25 inch pounds. ☑

3.6 Use the tooling that is provided to align the Z-Bracket on the narrow and wide end of the chamber. After the brackets are align, ensure that the Z-Bracket bolts are torqued at 50-60 inch pounds ☑

3.7 After all bolts have been re-torqued, check the appropriate box below, indicating that each chamber has been checked and reworked as per steps 3.4 - 3.6. ☑

Chamber #5 ☑
Chamber #4 ☑
Chamber #3 ☑
Chamber #2 ☑
Chamber #1 ☑

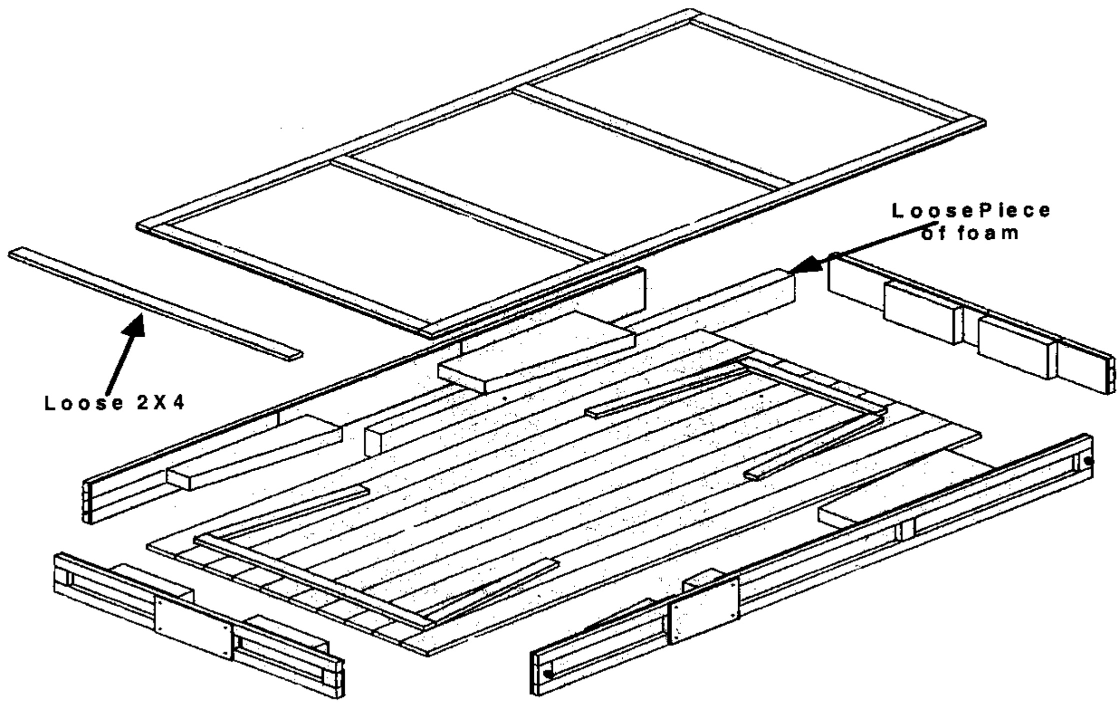
3.8 Verify that baggie with the HV switch cover and two screws are taped to the top of the chamber. ☑

Kerry G. Dear
Technician(s)

12-18-01
Date

4.0 Chamber Shipping Box Preparation/Assembly #1

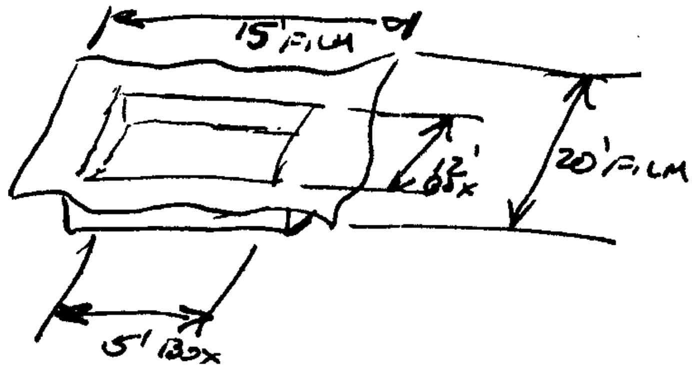
Completed



4.1	Transport the chamber-shipping box (MC-368681) by approved methods to the packing assy area.	☑
4.2	Remove the lid, then verify and remove the (2 x 4') loose piece of wood from the chamber shipping box, and the loose piece of foam.	☑
4.3	Verify that the precut foam pads are provided and in the correct position.	☑
4.4	Check the chamber-shipping box to make sure that the inside is clean if needed vacuum the dust and the dirt from the container.	☑

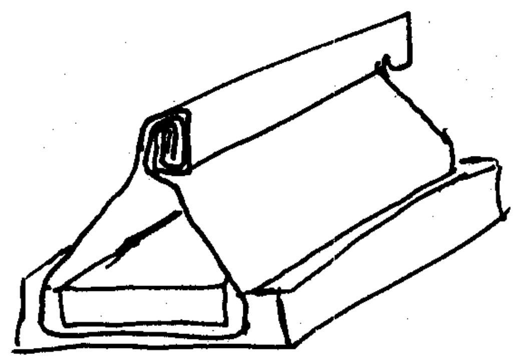
Completed

4.5 Push the anti-static film (VCI 126; 4mil; 15' x 20') into the box opening, where the ends of the anti-static film lay over the sides of the box. See diagram below.

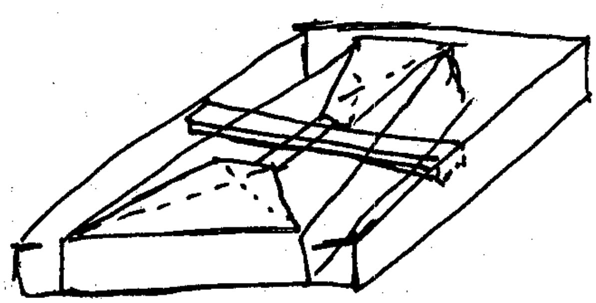


4.6 Attach the straps to the chamber lifting eyes in the four chamber corners, and use the approved method to pick up the chamber and carefully lower it in the chamber-shipping box.

4.7 After the chamber is in the shipping box, fold the long sides of the anti-static film over the chamber and secure it with green duct tape see diagram below.

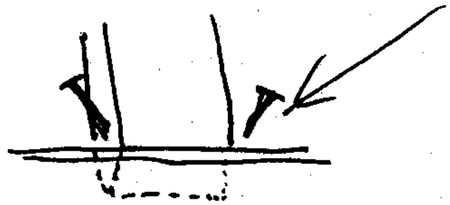


4.8 Fold the ends of the anti-static film over and secure with green duct tape to the chamber as per diagram below.



Completed

4.9 Place the loose foam filler pieces into position along the anode side of the chamber: Attach the 2 x 4 (46 - 48 inches) in from the narrow end, across the top of the box in the widthwise direction and secure with the provided screws. Applied from the inside of the box. See diagram below.



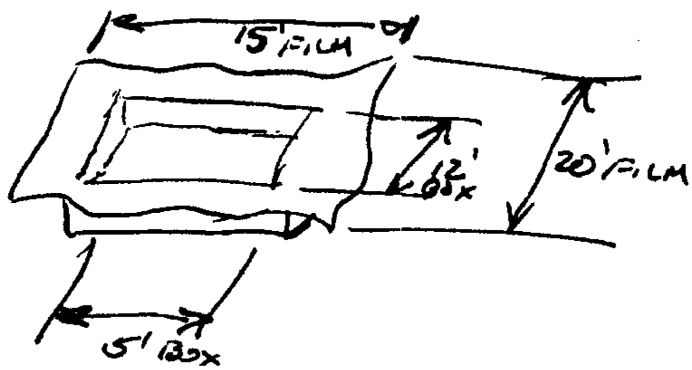
4.10 Carefully place the lid over the chamber box and secure with the screws that are supplied.

Technician(s)

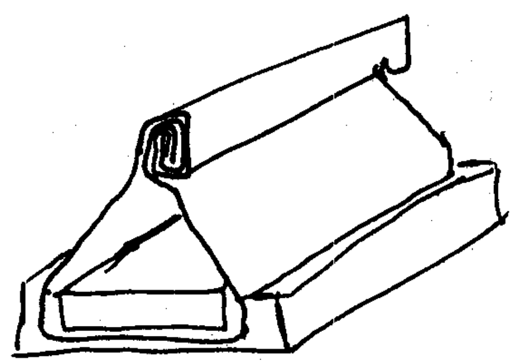
12-18-01
Date

5.0 Chamber Shipping Box Preparation/Assembly #2

			Completed
	5.1	Transport the chamber-shipping box (MC-368681) by approved methods to the packing assy area.	☑
	5.2	Remove the lid, then verify and remove the two (2 x 4's) loose pieces of wood from the chamber shipping box.	☑
	5.3	Verify that the precut foam pads are provided and in the correct position.	☑
	5.4	Check the chamber-shipping box to make sure that the inside is clean if needed vacuum the dust and the dirt from the container.	☑
	5.5	Push the anti-static film (VCI 126; 4mil; 15' x 20') into the box opening, where the ends of the anti-static film lay over the sides of the box. See diagram below.	☑

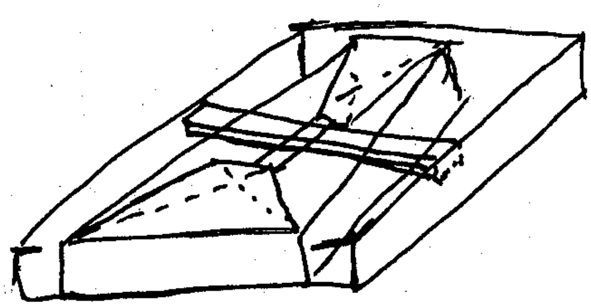


	5.6	Attach the straps to the chamber lifting eyes in the four chamber corners, and use the approved method to pick up the chamber and carefully lower it in the chamber-shipping box.	☑
	5.7	After the chamber is in the shipping box, fold the long sides of the anti-static film over the chamber and secure it with green duct tape see diagram below.	☑

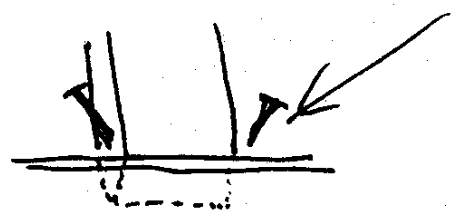


Completed

5.8 Fold the ends of the anti-static film over and secure with green duct tape to the chamber as per diagram below. ☑



5.9 Place the loose foam filler pieces into position along the anode side of the chamber: Attach the 2 x 4 (46 - 48 inches) in from the narrow end, across the top of the box in the widthwise direction and secure with the provided screws. Applied from the inside of the box. See diagram below. ☑



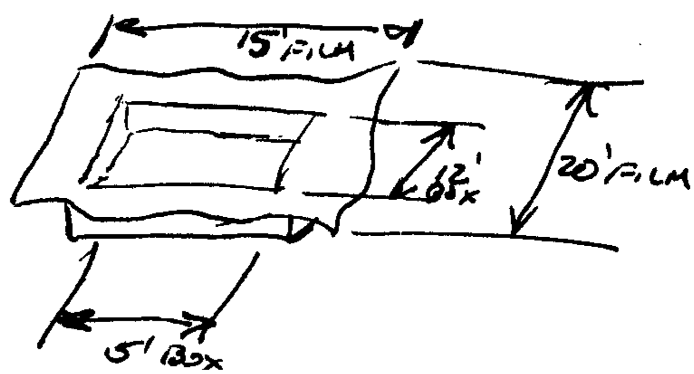
5.10 Carefully place the lid over the chamber box and secure with the screws that are supplied. ☑

Kerry Caldwell
Technician(s)

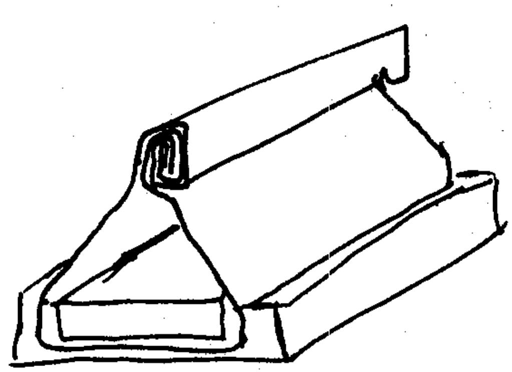
12-18-01
Date

6.0 Chamber Shipping Box Preparation/Assembly #3

		Completed
6.1	Transport the chamber-shipping box (MC-368681) by approved methods to the packing assy area.	☑
6.2	Remove the lid, then verify and remove the two (2 x 4's) loose pieces of wood from the chamber shipping box.	☑
6.3	Verify that the precut foam pads are provided and in the correct position.	☑
6.4	Check the chamber-shipping box to make sure that the inside is clean, if needed vacuum the dust and the dirt from the container.	☑
6.5	Push the anti-static film (VCI 126; 4mil; 15' x 20') into the box opening, where the ends of the anti-static film lay over the sides of the box. See diagram below.	☑

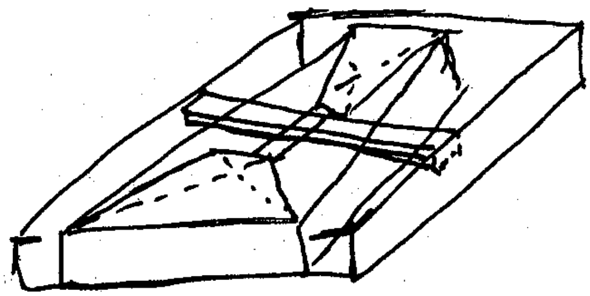


6.6	Attach the straps to the chamber lifting eyes in the four chamber corners, and use the approved method to pick up the chamber and carefully lower it in the chamber-shipping box.	☑
6.7	After the chamber is in the shipping box, fold the long sides of the anti-static film over the chamber and secure it with green duct tape see diagram below.	☑

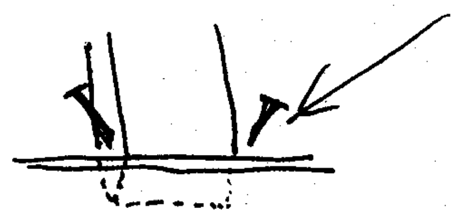


Completed

6.8 Fold the ends of the anti-static film over and secure with green duct tape to the chamber as per diagram below. ☑



6.9 Place the loose foam filler pieces into position along the anode side of the chamber: Attach the 2 x 4 (46 - 48 inches) in from the narrow end, across the top of the box in the widthwise direction and secure with the provided screws. Applied from the inside of the box. See diagram below. ☑



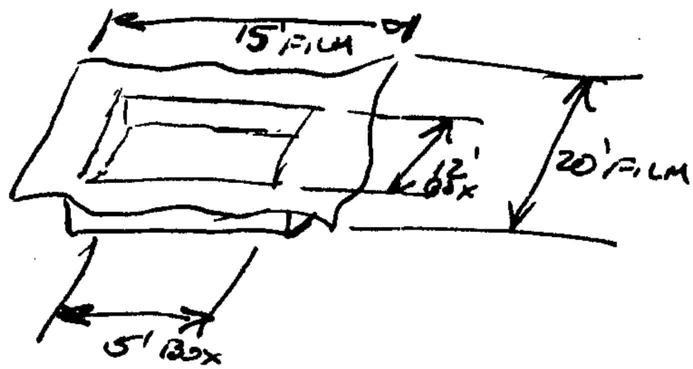
6.10 Carefully place the lid over the chamber box and secure with the screws that are supplied. ☑

[signature] 1-04-02

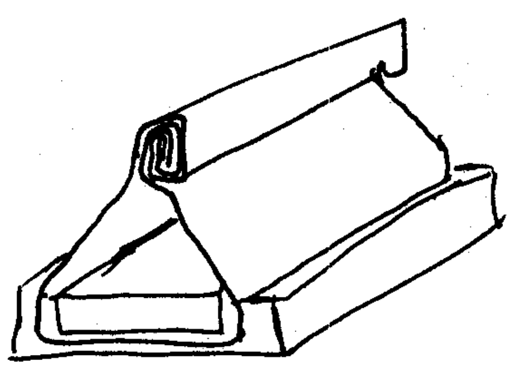
Technician(s) Date

7.0 Chamber Shipping Box Preparation/Assembly #4

		Completed
7.1	Transport the chamber-shipping box (MC-368681) by approved methods to the packing assy area.	☑
7.2	Remove the lid, then verify and remove the two (2 x 4's) loose pieces of wood from the chamber shipping box.	☑
7.3	Verify that the precut foam pads are provided and in the correct position.	☑
7.4	Check the chamber-shipping box to make sure that the inside is clean, if needed vacuum the dust and the dirt from the container.	☑
7.5	Push the anti-static film (VCI 126; 4mil; 15' x 20') into the box opening, where the ends of the anti-static film lay over the sides of the box. See diagram below.	☑

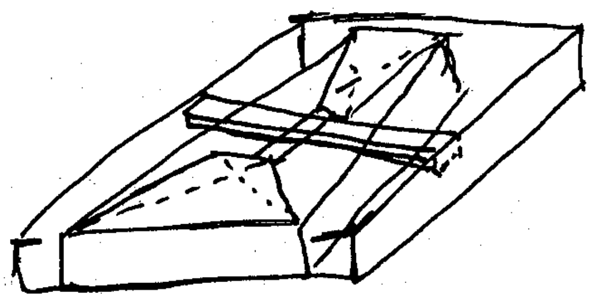


7.6	Attach the straps to the chamber lifting eyes in the four chamber corners, and use the approved method to pick up the chamber and carefully lower it in the chamber-shipping box.	☑
7.7	After the chamber is in the shipping box, fold the long sides of the anti-static film over the chamber and secure it with green duct tape see diagram below.	☑

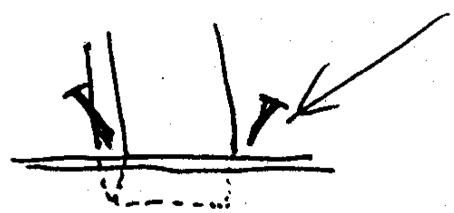


Completed

7.8 Fold the ends of the anti-static film over and secure with green duct tape to the chamber as per diagram below. ☑



7.9 Place the loose foam filler pieces into position along the anode side of the chamber: Attach the 2 x 4 (46 - 48 inches) in from the narrow end, across the top of the box in the widthwise direction and secure with the provided screws. Applied from the inside of the box. See diagram below. ☑



7.10 Carefully place the lid over the chamber box and secure with the screws that are supplied. ☑

[signature]
Technician(s)

1-9-02
Date

8.0 Chamber Shipping Box Preparation/Assembly #5

Completed

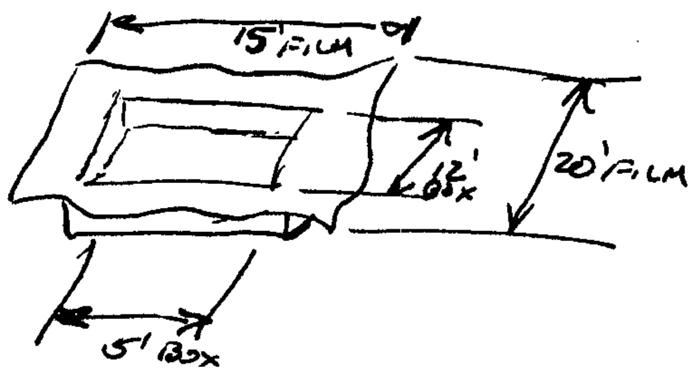
8.1 Transport the chamber-shipping box (MC-368681) by approved methods to the packing assy area.

8.2 Remove the lid, then verify and remove the two (2 x 4's) loose pieces of wood from the chamber shipping box.

8.3 Verify that the precut foam pads are provided and in the correct position.

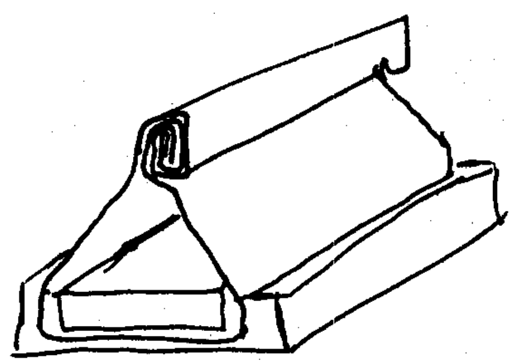
8.4 Check the chamber-shipping box to make sure that the inside is clean, if needed vacuum the dust and the dirt from the chamber-shipping box.

8.5 Push the anti-static film (VCI 126; 4mil; 15' x 20') into the box opening, where the ends of the anti-static film lay over the sides of the box. See diagram below.



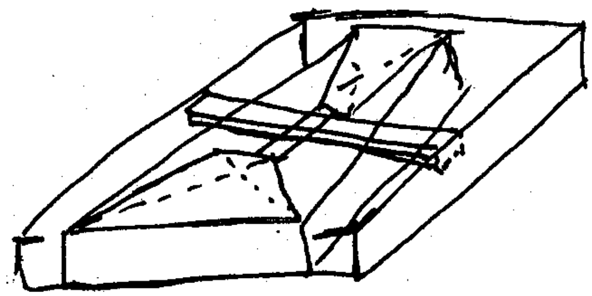
8.6 Attach the straps to the chamber lifting eyes in the four chamber corners, and use the approved method to pick up the chamber and carefully lower it in the chamber-shipping box.

8.7 After the chamber is in the shipping box, fold the long sides of the anti-static film over the chamber and secure it with green duct tape see diagram below.

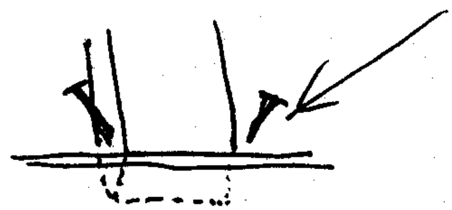


Completed

8.8 Fold the ends of the anti-static film over and secure with green duct tape to the chamber as per diagram below. ☑



8.9 Place the loose foam filler pieces into position along the anode side of the chamber: Attach the 2 x 4 (46 - 48 inches) in from the narrow end, across the top of the box in the widthwise direction and secure with the provided screws. Applied from the inside of the box. See diagram below. ☑



8.10 Inspect lifting rings to ensure there is no damage to them. ☑

8.11 Include one set (4) of lifting rings with every five chambers, and leave them in the chamber. ☑

8.12 Send a copy of the Chamber Assembly and Chamber Electrical travelers of each chamber with the stack set. ☑

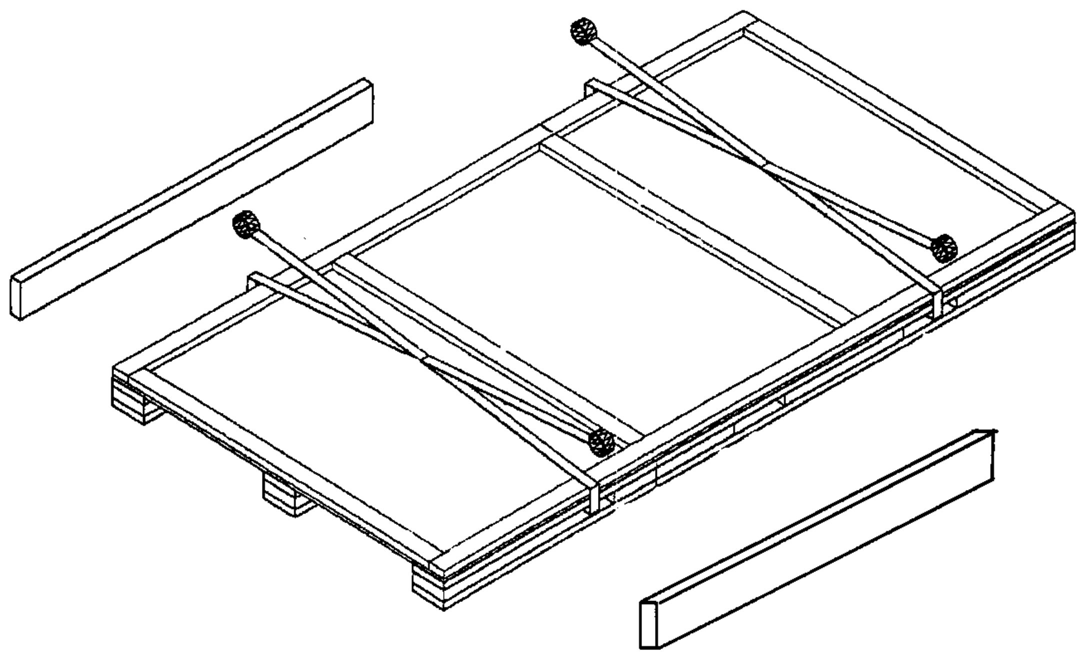
8.13 Carefully place the lid over the chamber-shipping box and secure with the screws that is supplied. ☑

Kerry A Dee ____________________ 1-15-02 ____________________
Technician(s) Date

9.0 Stack Set Assembly/Shipping

Completed

9.1 Prepare the chamber-stacking skid (MC-368682). Unfold the skid slings so the are out of the way of loading of the chamber shipping boxes.



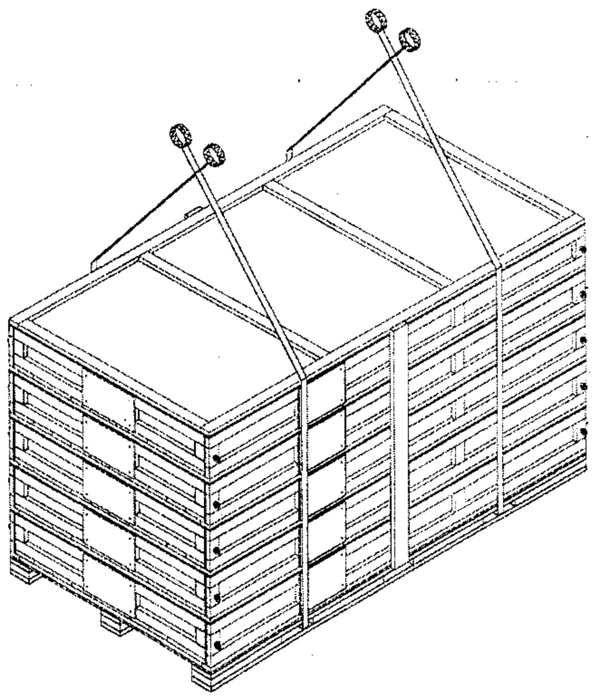
9.2 Stack the five chambers shipping boxes with shipping box #1 in the base position and shipping box #5 in the top position, using slings and the provided chamber lifting eyes.

Note(s):

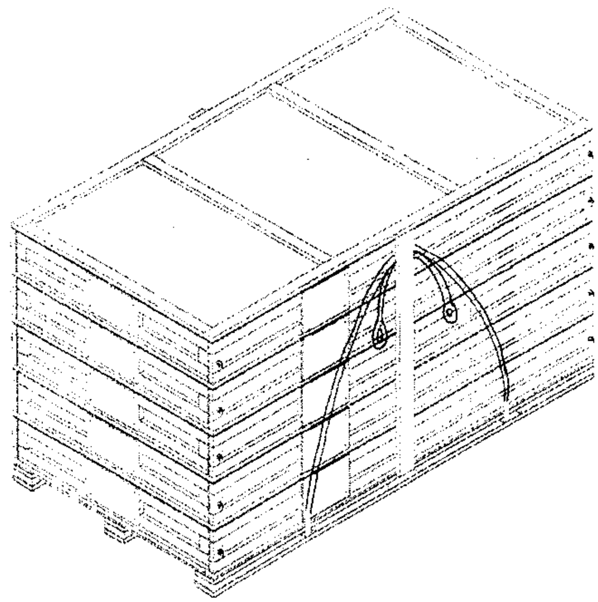
All chamber shipping boxes must be stacked so that the shipping box windows are all on the same sides. (See picture @ Step 9.4).

9.3 Once all the chamber-shipping boxes are stacked together, attach the two 2 x 6's that are provided to center of the sides of the stack. Secure the 2x6's to the skid on the bottom and the top of the chamber lid using the screws that are provided.

9.4 Using the provided slings load the stack set of 5 chamber shipping boxes onto the truck. Once on the truck, tuck the four sling straps behind and around the 2 x 6's at the top chamber shipping.box and secure slings and sling ends to prevent damage during shipping.



Shown with Slings in Lifting Mode



Shown with Slings in Transport Mode

9.5 In the chart below record where the stack set will be transported to.

	Stack Set Serial Number
University of Florida X	013 2-8-02 PF
UCLA	
Other	ICB (STORAGE)

Technician(s)

1-15-02
Date

10.0 Production Complete

XXX 10.1 Process Engineering verify that the Chamber Packaging and Shipment (5520-TR-333256) is accurate and complete. This shall include a review of all steps to ensure that all operations have been completed and signed off. Ensure that all Discrepancy Reports, Nonconformance Reports, Repair/Rework Forms, Deviation Index and dispositions have been reviewed by the Responsible Authority for conformance before being approved.

Comments:

Pamela Blom
Process Engineering/Designee

1/23/02
Date

Attn: Linda Alsip

Created on 3/12/98

ADDITIONAL PARTS REQUEST

THIS FORM IS TO BE USED TO ACCESS ADDITIONAL, MISSING, OR REPLACEMENT PARTS

THIS FORM MUST BE SIGNED BY AN ACQUISITIONER BEFORE BRINGING TO THE STOCKROOM

PANEL OR CHAMBER NUMBER: ME234/2
DATE: 11/6/01
BUDGET CODE: EPK

REQUESTED BY: Pamela Isham
DELIVER TO: MP 9
NEED BY DATE: 11/6/01

ISSUE VERIFICATION:

ACQUISITIONER SIGNATURE L Alsip DATE 11-6-01

CHECK ONE:
____ENTIRE KIT; ____PATRS SET; X INDIVIDUAL PARTS; ____CONSUMABLES

PLEASE REQUEST THE REVISION YOU NEED

	PART NUMBER	REV	QTY	DESCRIPTION	ROUTING FORM
IB4-BIN	1. 368078		40	Ring hoist	73238
	2.				
	3.				
	4.				
	5.				
	6.				

STOCKROOM SIGNATURE [signature] ID# 12698 DATE 11/6/01

ORIGINAL PARTS STATUS (CHECK ONE)

____DEFECTIVE PARTS ISSUED; ____PARTS SCRAPED; ____PARTS LOST

____DEFECTIVE ASSEMBLY; ____MISSING FROM KIT ALREADY ISSUED; X OTHER

SEND THIS FORM WITH PARTS TO INCLUDE WITH THE TRAVELER

PARTS RECEIVED BY: Pamela Isham ID# 31685C DATE 11/6/01

Attn: Linda Alsip

Created on 3/12/98

ADDITIONAL PARTS REQUEST

THIS FORM IS TO BE USED TO ACCESS ADDITIONAL, MISSING, OR REPLACEMENT PARTS

THIS FORM MUST BE SIGNED BY AN ACQUISITIONER BEFORE BRINGING TO THE STOCKROOM

PANEL OR CHAMBER NUMBER: ME234/2
DATE: 11/6/01
BUDGET CODE: EPK

REQUESTED BY: Pamela Isham
DELIVER TO: MP 9
NEED BY DATE: 11/6/01

ISSUE VERIFICATION:

ACQUISITIONER SIGNATURE Mark Stent DATE 11-6-01

CHECK ONE:
______ENTIRE KIT; ______PATRS SET; __X____INDIVIDUAL PARTS; ____CONSUMABLES

PLEASE REQUEST THE REVISION YOU NEED

PART NUMBER	REV	QTY	DESCRIPTION	ROUTING FORM
1. 368673		40 ~~10 sets~~	Lifting Rings	74745
2.				
3.				
4.				
5.				
6.				

STOCKROOM SIGNATURE Pam Schmidt ID# 5158 DATE 11/6/01

ORIGINAL PARTS STATUS (CHECK ONE)

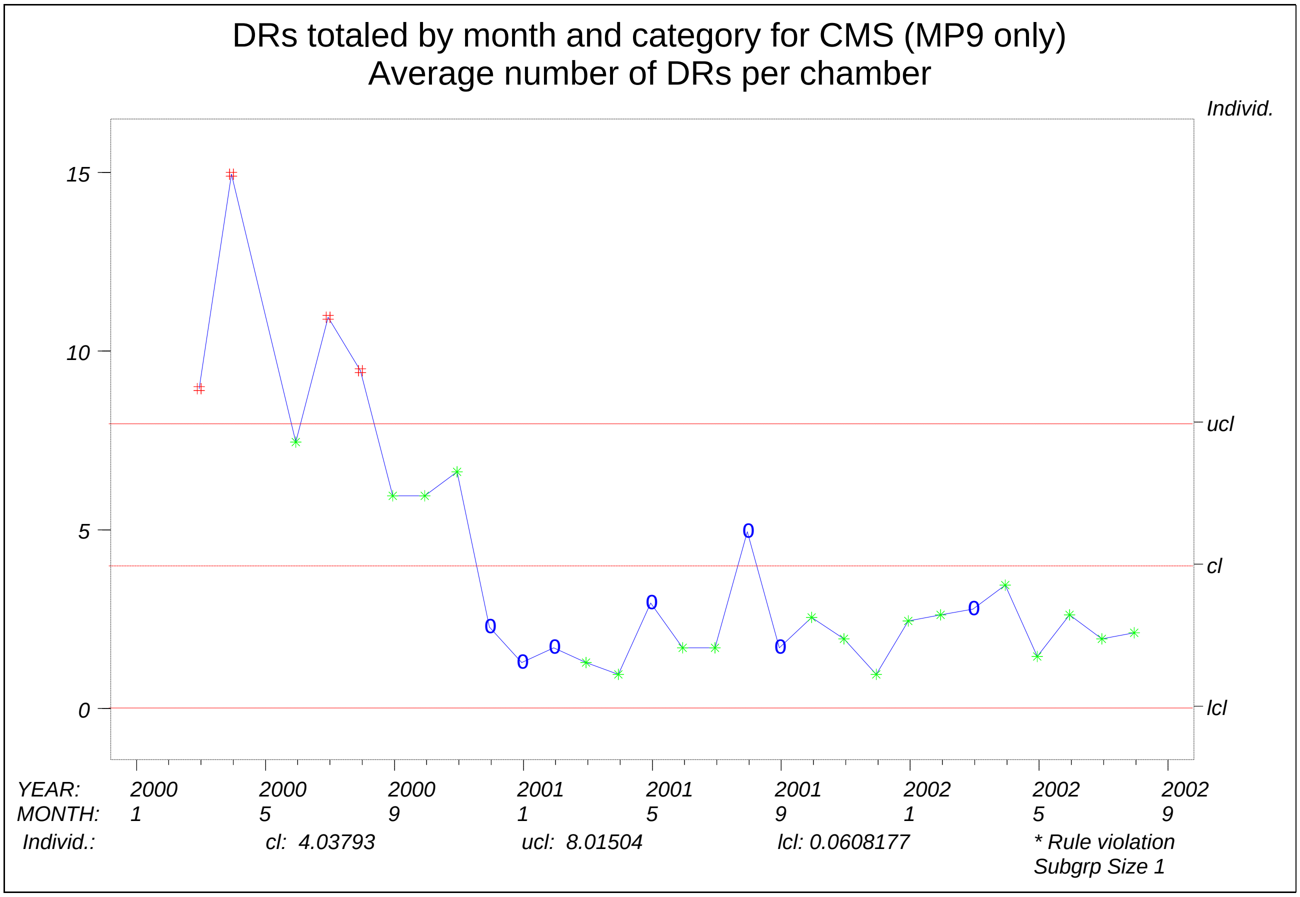
______DEFECTIVE PARTS ISSUED; ______PARTS SCRAPED; ______PARTS LOST

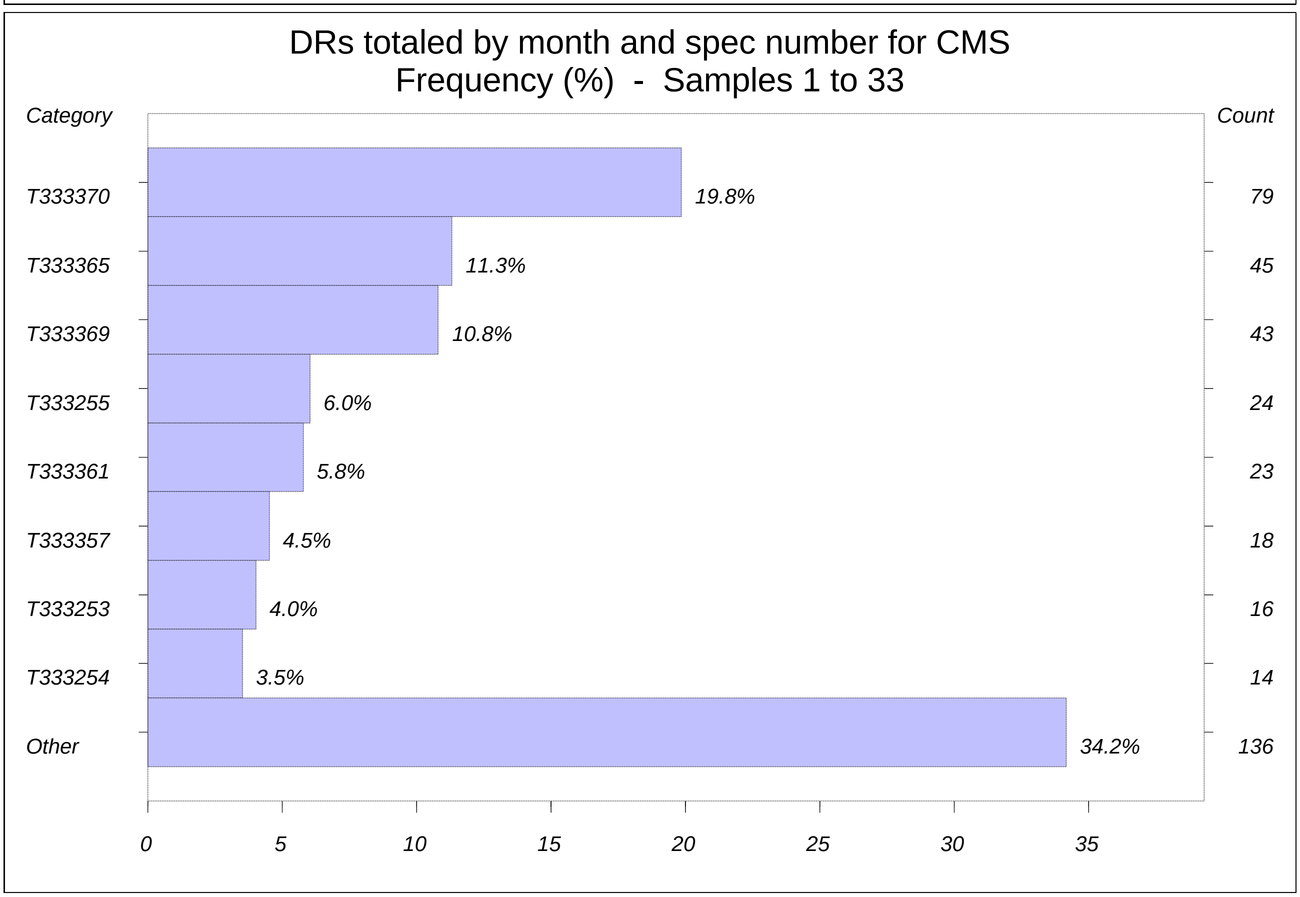
______DEFECTIVE ASSEMBLY; ______MISSING FROM KIT ALREADY ISSUED; X____OTHER

SEND THIS FORM WITH PARTS TO INCLUDE WITH THE TRAVELER

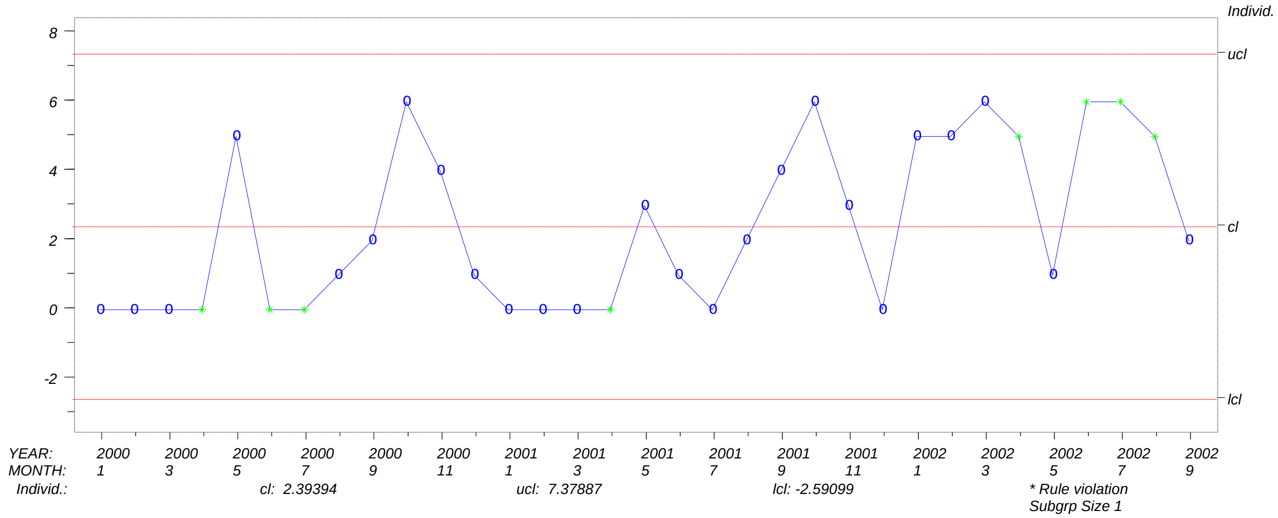
PARTS RECEIVED BY: Pamela Isham ID# 30686 DATE 11/6/01

Never received for the stack set.

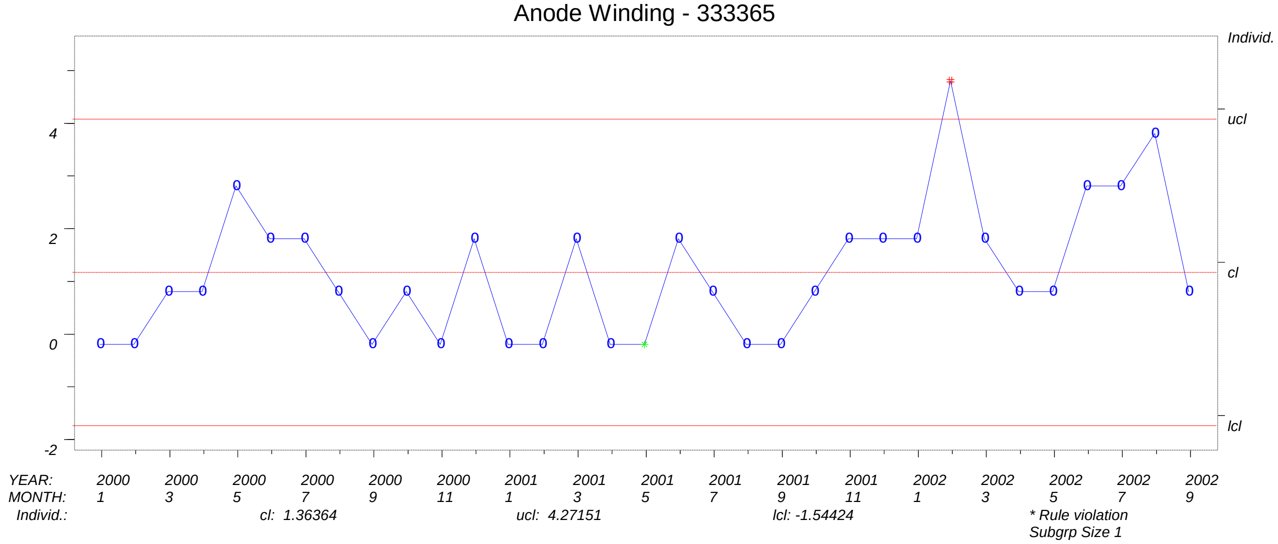

DRs totaled by month and category for CMS (MP9 only)
Average number of DRs per chamber
Individ.
15
10
5
0
ucl
cl
lcl
YEAR: 2000 2000 2000 2001 2001 2001 2002 2002 2002
MONTH: 1 5 9 1 5 9 1 5 9
Individ.: cl: 4.03793 ucl: 8.01504 lcl: 0.0608177
* Rule violation
Subgrp Size 1


DRs totaled by month and spec number for CMS
Frequency (%) - Samples 1 to 33
Category
Count
T333370 19.8% 79
T333365 11.3% 45
T333369 10.8% 43
T333255 6.0% 24
T333361 5.8% 23
T333357 4.5% 18
T333253 4.0% 16
T333254 3.5% 14
Other 34.2% 136
0 5 10 15 20 25 30 35

DRs totaled by month and spec number for CMS
Chamber Assembly - 333370



DRs totaled by month and spec number for CMS
Anode Winding - 333365



DRs totaled by month and spec number for CMS
Anode Tension Testing - 333369